NASA/TM-2000-209891, Vol. 1



Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and David E. Knapp, Editors

Volume 1 BOREAS AFM-1 NOAA/ATDD Long-EZ Aircraft Flux Data Over the SSA

T.L. Crawford, D. Baldocchi, L. Gunter, and E. Dumas

National Aeronautics and Space Administration

Goddard Space Flight Center Greenbelt, Maryland 20771

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BOREAS AFM-1 NOAA/ATDD Long-EZ Aircraft Flux Data over the SSA

Timothy L. Crawford, Dennis Baldocchi, Laureen Gunter, Ed Dumas

Summary

This data set contains measurements from the AFM-1 NOAA/ATDD Long-EZ Aircraft collected during the 1994 IFCs at the SSA. These measurements were made from various instruments mounted on the aircraft. The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling PAR, greenness index, CO₂ concentration, O₃ concentration, and CH₄ concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data. The data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS AFM-01 NOAA/ATDD Long-EZ Aircraft Flux Data over the SSA

1.2 Data Set Introduction

This data set contains measurements from the National Oceanic and Atmospheric Administration (NOAA) Atmospheric Turbulence and Diffusion Division (ATDD) Long-EZ Aircraft collected during the 1994 Intensive Field Campaigns (IFCs) at the BOReal Ecosystem-Atmosphere Study (BOREAS) Southern Study Area (SSA). These measurements were made from various instruments mounted on the aircraft. The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static

pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling photosynthetically active radiation (PAR), greenness index, CO_2 concentration, O_3 concentration, and CH_4 concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data. The data are stored in tabular American Standard Code for Information Interchange (ASCII) files.

1.3 Objective/Purpose

The primary objective was to measure the vertical flux density of sensible and latent heat, CO₂, ozone, and momentum for extrapolating surface-based measurements to regional scales. An ultimate objective is to develop algorithms to relate boundary-layer processes to satellite-derived data.

The Airborne Fluxes and Meteorology (AFM)-01 team measured water vapor, sensible heat, CO₂, and O₃ air-surface exchange from the boreal forest to study the factors that control spatial variability of the exchange. Scalar flux densities were measured with ATDD's Long-EZ flux aircraft. The purpose of its flights was to observe energy, momentum, carbon, and ozone air-surface exchange with a 3-km resolution. Additionally, supporting meteorological parameters such as temperature, humidity, CO₂ and O₃ concentration, wind speed and direction, surface temperature, and incoming and net radiation were observed. All data were tagged with accurate time, position, and altitude. It is expected that these data will also be used to relate surface exchange to radiometric data available from satellites, i.e., validation of satellite data. Through this research, it is hoped that techniques can be developed to more accurately model air/surface exchange and to use satellite data for global monitoring of landscape health and climate change.

1.4 Summary of Parameters

The following parameters have been submitted to the BOREAS Information System (BORIS) data base: temperature, dewpoint temperature, pressure, incoming and outgoing PAR, net radiation, wind velocity, H_2O mixing ratio, CO_2 mixing ratio, ozone mixing ratio, sensible heat flux, latent heat flux, momentum flux, CO_2 flux, O_3 flux, aircraft position, altitude (radar and pressure), and surface temperature.

Profile parameters are not available at this date.

1.5 Discussion

NOAA operated the Long-EZ in the one 1993 IFC and in all three 1994 IFCs. However, only the 1994 data are included in this data set. The main purpose of Long-EZ flights was to observe energy, momentum, ozone, and carbon dioxide air-surface exchange. The Long-EZ's strength is its ability to observe spatial variability in surface exchange with a 3-km resolution. This is accomplished by flying low (at 10 to 15 m above the surface) and slow (50 m/s) while making high-frequency eddy flux measurements. Due to the short sampling time of 60 s, the flux variance in the reported 3-km segments is large. However, each 3-km segment is an unbiased estimate of the mean, and variance can be reduced by transects' superposition. Ideally, six repeated transects should be superimposed. This is usually possible since a key element of the Long-EZ flight plans is repeated observations.

The data were collected during straight and level flux runs over the BOREAS site and in various project areas. A variety of flight strategies is reported (the Candle Lake transect, asterisks, grids, "L" patterns, soundings, etc.), from those described in the BOREAS experimental plan. The archive data include segment-averaged data, focusing on the fluxes, and the supporting meteorological, radiometric, and aircraft positional data. No attempt will be made to archive the high rate (40 Hz) "raw" or processed output data (POD), which can be acquired from ATDD by special request. The references give a complete description of the Long-EZ and its instrument systems. The following table gives a quick overview of flight operations.

IFC 93	<u>IFC 1</u>	IFC 2	IFC 3	TOTAL
46	83	75	68	272
84	98	33	71	296
	44	47	23	114
	37		32	69
15	35	55	32	137
		5	3	8
	6	14		20
	28	5	2	35
	18	8	2	28
	46 84 	46 83 84 98 44 37 15 35 6 28	46 83 75 84 98 33 44 47 37 15 35 55 5 6 14 28 5	46 83 75 68 84 98 33 71 44 47 23 37 32 15 35 55 32 5 3 6 14 28 5 2

NOTES: 1. Summary excludes experimental sampling patterns and miscellaneous sites. 2. Flight hours include all flight operations except ferry to and from Tennessee. 3. A pass is any flux tower crossing. Site-specific patterns such as "asterisk", 8's, and button holes were centered on the flux towers.

1.6 Related Data Sets

BOREAS AFM-02 Wyoming King Air 1994 Aircraft Flux and Moving Window Data

BOREAS AFM-02 Wyoming King Air 1994 Aircraft Sounding Data

BOREAS AFM-03 NCAR Electra 1994 Aircraft Flux and Moving Window Data

BOREAS AFM-03 NCAR Electra 1994 Aircraft Sounding Data

BOREAS AFM-04 Twin Otter Aircraft Flux Data

BOREAS AFM-04 Twin Otter Aircraft Sounding Data

BOREAS AFM-11 Aircraft Flux Analysis and Comparison PDF Documents

2. Investigator(s)

2.1 Investigator(s) Name and Title

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2.2 Title of Investigation

AFM-01: Experimental and Modeling Studies of Water Vapor, Heat and CO₂ Exchange over a BOREAL Forest

2.3 Contact Information

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3. Theory of Measurements

Air-surface exchange, or the surface flux, is a fundamental boundary condition controlling the atmospheric mass, momentum, and energy budgets. The species exchanged at the surface passes through the near surface boundary layer by turbulent transport. Thus, the surface exchange may be determined by measuring the near-surface turbulent or "eddy" flux. The eddy flux measurement is simple in concept, mathematically expressed as the covariance

$$F = \langle (rw)'s' \rangle$$
 3.1

Here (rw)' is the turbulent fluctuation of the product of the dry air density and vertical velocity (i.e., dry air mass flux density), and s' is the turbulent fluctuation in the mixing ratio, relative to dry air, of the species of interest. The angle brackets indicate the appropriate ensemble average.

This method has a first-principles basis, and a direct noninvasive nature. Since the near-surface flux is directly observed, the only assumption is that the flux divergence or gradient between the measurement and the surface is small. This assumption is valid when the mean transport, sources, and storage terms within the conservation equation are small. The reliability of this assumption weakens with increasing measurement altitude, and/or increasingly complex atmospheric and site conditions.

The measurement principles for wind velocity and species concentration are well developed. Since the flux measurement is made above the surface without disturbing the surface, it cannot influence the exchange observed. Tower observations using a 15-min time scale, and airborne observations using a 3-km space scale, give data with sufficiently small time/space scale to permit the process studies needed to improve predictive capabilities. In the last 10 years, the accuracy of this technique has improved because of significant advancements in instrumentation and processing techniques.

However, the details associated with proper instrument operation, data processing, and data interpretations are complex. This is especially true for airborne flux systems. For aircraft, both the instrument systems and data processing programs are more complex when compared to tower systems. For example, to determine wind velocity on an aircraft, the air velocity relative to the sensors is added to the sensor velocity relative to Earth. Both vectors are large and nearly cancel each other out (i.e., similar magnitude, opposite signs). Neither vector can be directly observed, but must be synthesized from many sensors. The synthesis process is intolerant to phase or amplitude errors introduced by sensors, data systems, or processing algorithms.

Eddy Flux Measurement Theory

The eddy flux method allows the short-term measurement of flux densities (vertical transport of mass, momentum, and energy per unit area and time). The measurement becomes especially powerful, but often difficult to interpret, when made from an aircraft. Aircraft turbulence data derive their power from information density per unit time, and the spatial freedom of the measurement platform. Both require greater effort in an analysis. Further, interpretation of aircraft data becomes more difficult whenever the data set also contains spatial trends and inhomogeneities. Mass conservation provides the basic framework for correct interpretation. Conservation of a conservative species, s, requires that the time rate of change of s within a control volume be balanced by the mean and turbulent flux through the volume's boundaries.

From the Long-EZ, fluxes are measured usually around 15 m above the surface (higher from other

aircraft and lower from towers). The flux measurement accurately defines the flux occurring at the flight altitude and along the flight track. However, most are interested in the surface flux. The flux observed at a flight altitude represents the surface flux if the following conditions are met.

- The flight altitude is low enough to be within the constant flux layer. Above this, flux divergence becomes increasingly important with increasing altitudes, which makes the observed flux no longer representative of the surface flux. Such flux divergence usually causes an underestimate of the surface flux, but not always. Typically, mitigating concerns about flux divergence requires measurement within the lowest 10% of the turbulent boundary layer. With the exception of stable night boundary layers, the Long-EZ's 15 m sampling altitude satisfies this condition. However, the importance of storage and transport terms below the flight altitude should be considered. In unusual situations such as front passages, strong temperature, or species advection, such terms can still become significant.
- The underlying surface is homogeneous. It should extend upwind of the flight track for about 100 times the sampling altitude. Also, it should extend along the flight track for a distance equivalent to the space average being applied in data processing. This ensures the development of an equilibrium surface boundary layer and adequate sampling time before conditions change. Airplane measurements remain valid whether or not these conditions are met. However, small-scale inhomogeneity greatly increases the difficulty of specifying and interpreting the mean state from which the turbulence departs and introduces samples from multiple populations into the measurement set. This difficulty increases as the contrast between inhomogeneous regions increases.
- Stationary meteorological conditions should prevail during sampling. Such conditions as frontal passage and nightfall clearly violate this, featuring important contributions from the horizontal transport or storage terms, explicitly rejected by Eq. 3.1. However, less abrupt change can also be important. For example, if the air is warming 3 deg/hr, the heat flux at 15 m (Long-EZ flight level) will be 20 W/m² less than at the surface due to storage.
- Below the measurement height, s must be a conservative property. Fast chemical reactions involving s invalidate this assumption. For example, ozone reacts rapidly with NO. If there is a significant NO emission below the sampling altitude (soil flux or automobile emissions), it could easily lead to an incorrect interpretation of the observed flux.

Eddy Flux Technique

A significant part of the complexity of this measurement lies in separating turbulent fluctuation from mean, and defining an appropriate ensemble average. Equation 3.1 is not computationally useful until the turbulent fluctuations are defined. Traditionally, the fluctuations are defined as

$$s = s' + S$$
 3.2

where S is the appropriate ensemble mean of s.

Given this definition, Eq. 3.1 may be rewritten as

$$F = \langle (rw) - (RW) | (s - S) \rangle = \langle (rw)s - (RW)S \rangle$$
 3.3

Here (RW) is not the product of the mean of the dry air density and the mean vertical velocity but the mean of their product. For heat flux, s = Cp*T where Cp is the moist air specific heat at constant pressure. Cp depends locally (i.e., at 40 Hz) on water vapor concentration. T is the potential temperature. The use of potential temperature compensates for the compressible nature of the atmosphere. Since there is a correlation between w and the aircraft altitude, the use of potential temperature is necessary to eliminate this false (rw)t correlation. For latent heat flux, s = Lq where L is the local temperature-dependent evaporation energy for water and q is the water vapor mixing ratio relative to dry air. For CO_2 , s becomes the CO_2 mixing ratio relative to the dry air component. This approach satisfies the constraint outlined by Webb et al. (1980) (no flux of dry air), and implicitly

corrects all fluxes for heat and water vapor transport.

On a tower, the mean is a time average. The fluctuation is then obtained as s' = s - S where S is the average over periods of around 15 to 30 min. However, s observed from an airplane contains both space- and time-related trends. In aircraft flux data, a space trend should also be considered. This is a tedious and difficult correction that requires much investigator interpretation. Only time trends have been removed for data submitted to BORIS.

Eddies in a wide range of scales contribute to turbulent transfer. Successful eddy flux measurement requires proper sampling over this spectrum. The eddy size is expressed by a dimensionless frequency, nz/u, where n is the eddy size as a frequency, z the sampling height, and u the eddy transport speed past the sensor. The important eddy size ranges contributing to turbulent transfer are typically within 0.005 < nz/u < 5. For the Long-EZ, u = 50 m/s and z = 10 m. Therefore, from the Long-EZ, eddy sizes between 1.25 m and 1,250 m are important. Over deciduous forest during typical daytime turbulent conditions, little flux contribution occurs outside this range (Anderson et al. (1986)). However, due to the greater roughness of the BOREAS site, we suspect the important eddy flux range may be driven to longer wavelengths. The nz/u scaling points out the need for and advantage of fast-response turbulent measuring systems. Fast-response sensors/data systems combined with low-altitude flying allow the contributing eddies to be sampled in a shorter time and enhance the spatial resolution of the flux observation.

The significant heterogeneity of the BOREAS experimental site makes it difficult quantitatively to specify the important eddy-size range contributing to turbulent transfer. Traditional spectral analysis is not appropriate due to strong site heterogeneity. To address this issue, two Candle Lake transects were processed with various covariance time scales or wavelength. The average flux along the transect normalized by the largest covariance result is presented in the following table. As the table shows, little flux is lost even at 20 s; therefore, our 60-s choice for BORIS submission is conservative.

Wavelength	<u>U*</u>	<u>H</u>	$\underline{\mathbf{LE}}$	FluxCO ₂
5 s (250 m)	0.05	0.7	0.7	0.8
10 s (500 m)	0.69	0.9	0.8	0.9
20 s (1000 m)	0.39	0.9	0.9	0.9
30 s (1500 m)	0.24	0.9	0.9	0.9
40 s (2000 m)	0.16	0.9	0.9	0.9
60 s (3000 m)	0.10	0.9	0.9	0.9
80 s (4000 m)	0.01	1.0	0.9	0.9
100 s (5000 m)	0.03	0.9	1.0	1.0
110 s (5500 m)	0.00	0.9	0.9	0.9

Evaluating the accuracy of the eddy correlation method is not straightforward. Factors contributing to uncertainties are instrument errors, sensor time response, signal-to-noise ratio, sensor separation distance, height of the measurement, signal attenuation due to path averaging, and corruption through tubing. Natural variability, due to nonsteady conditions, turbulence intermittency, and surface inhomogeneities, can add additional uncertainty. Under ideal meteorological and site conditions, natural variability is around $\pm 10\%$. Therefore, systems should be designed with an error less than this. However, the biggest problems with aircraft data are not related to data accuracy, but to data interpretations. Aircraft data implicitly represent a space average. The spatial variance is usually larger than 10%.

4. Equipment

4.1 Sensor/Instrument Description

The equipment used for the airborne flux measurement includes ATDD's Long-EZ flux research aircraft, the airborne flux instrumentation, and ATDD's data reduction hardware with software. These three systems were specifically designed and manufactured by ATDD staff to ensure high-fidelity flux observations. The optimum use of this airborne system is boundary layer flux measurement.

Long-EZ Description

The Long-EZ flux research aircraft, N3R, is well suited and is specifically instrumented for high-fidelity, air-surface-exchange research (Crawford et al., 1996). The wide-body Long-EZ is an experimental aircraft built by Timothy L. Crawford. It is a larger, higher-powered, and more capable version of the Rutan Long-EZ, a two-passenger, high-performance canard airplane. The aerodynamic characteristics of the Long-EZ are well suited for high-fidelity turbulent flux measurement. The pusher configuration leaves the front of the airframe free of propeller-induced disturbance, engine vibration, and exhaust. The small, laminar-flow airframe has an equivalent flat plate drag area of 0.2 m². As a result, the nose region has small flow disturbance and is ideal for high-fidelity measurements of winds, temperature, and trace species. The canard design cannot stall and has superior pitch stability in turbulent conditions. This, combined with its low wing loading, allows for safe low-speed (50 m/s), low-altitude (10 m) flux measurement. For enhanced safety, the Long-EZ is equipped with a ballistically deployed safety parachute (deployment requires 0.9 s).

The Long-EZ has an empty weight of 430 kg and a maximum gross takeoff weight of 800 kg. The aircraft service ceiling of 9,000 m must be reduced to 5,500 m because of oxygen system limitations. Endurance significantly exceeds 10 hours and a 2,000-nm range; however, pilot fatigue precludes routine 10-hour missions. More typical operations are two 4-hr or three 3-hr missions. Although small size (low flow distortion) is important to high-quality turbulence measurements, it is also a disadvantage. The small size combined with the current instrumentation leaves little room for additional instruments.

Airborne Flux Instrumentation Description

Wind velocity and virtual temperature fluctuations were measured with ATDD's turbulence probe (Crawford and Dobosy, 1992). The probe is mounted five chord lengths ahead of the wings, where flow disturbance is small. It carries pressure, temperature, and acceleration sensors in a nine-hole pressure-sphere gust probe of ATDD design. This sensor suite is specifically designed to extend eddy flux measurement at the higher frequencies required for low altitude flight. A thermistor in the central pressure port provides simultaneous temperature measurement, at a location symmetrical with respect to the flow, for accurate determination of true air speed and heat flux. CO₂ and water vapor fluctuations were measured with an open-path, infrared gas absorption (IRGA) analyzer, developed at ATDD (Auble and Meyers, 1992). This sensor responds to frequencies up to 40 Hz and has low noise and high sensitivity (for CO₂, 20 mg/m³/v). The sensor is rugged and experiences little drift. A unique difference in the Long-EZ instrument system is its pioneering use of a differential Global Positioning System (GPS) for extremely accurate position, velocity, and platform attitude measurement.

The airborne flux instrumentation and the data system with its associated software were specifically designed and built by ATDD (Crawford et al., 1991). This system connects to the pilot's digital interface, which controls instrument power distribution, two-way "smart" instrument communication, and the data-storage algorithm. The data stream is dominated by the high-frequency analog signals. Analog signals are first electronically conditioned by 30-Hz lowpass Butterworth anti-aliasing filters. The conditioned and voltage scaled signals are then digitized at 200 Hz. The 200-Hz data are digitally filtered and subsampled to 40 Hz. Although several other data frequencies are being written to disk, all are synchronized to a single clock frequency. Spectra and cospectra data analysis show that the 40-Hz flux data rate is adequate for measuring fluxes above forest canopies at the Long-EZ flight speed and altitude.

Data Reduction Hardware with Software

The eddy flux densities are determined by calculating the covariance between vertical velocity and scalar fluctuations while correcting for aircraft speed variations (Crawford et al., 1993a).

4.1.1 Collection Environment

Data were collected during IFCs 1, 2, and 3 under flight conditions outlined in the BOREAS Flight Plans for flux aircraft.

4.1.2 Source/Platform

The platform used to collect this data was a Long-EZ aircraft built by Timothy Crawford.

4.1.3 Source/Platform Mission Objectives

The mission objective was to collect CO_2 , O_3 , and CH_4 concentrations as well as other atmospheric and radiation parameters over various BOREAS sites.

4.1.4 Key Variables

The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling PAR, greenness index, CO_2 concentration, O_3 concentration, and CH_4 concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data.

4.1.5 Principles of Operation

None given.

4.1.6 Sensor/Instrument Measurement Geometry

ATDD's turbulence and heat flux probe is mounted on the airplane at the end of a 1-m nose boom. This places the probe five wing chords in front of the canard and six wing chords in front of the main wing. All high-frequency motion (acceleration, pressure, and temperature) sensors are within the nine-hole pressure sphere. The center of the sphere is the origin of the computational coordinate system. A backup fast-response temperature sensor and slow-response temperature sensor for calibration reference are mounted on the nose of the airplane along with ATDD's fast-response IRGA H₂O/CO₂ analyzer. Forward on the left side of the nose is the net radiometer. The small airframe size results in very small solid angle interference from the airframe at the nose. Located at the aircraft center of gravity (CG) are the low-frequency reference sensors for H₂O, CO₂, and O₃. The infrared surface temperature sensor, the chilled-mirror dewpoint hygrometer, and the fast-response O₃ analyzer are also at this location. The infrared temperature sensor is nadir-mounted through the floor. With its 15-degree field of view, it "sees" a 5-m-wide footprint. There are six GPS antennae strategically placed around the airframe, which are connected to three separate GPS receivers. The critical system is a four-antennae differential GPS (DGPS) attitude system. Attitude is determined by differentially measuring the relative positions, within 1 cm, of nose, tail and wing antennae. The current GPS is limited to operation at 4 Hz. A system upgrade with associated software enhancements is expected to allow this system to operate at 10 Hz in the future. When the attitude system output is increased to 10 Hz, one of the redundant GPS position receivers and the three-axis gyro system at the CG can be eliminated.

4.1.7 Manufacturer of Sensor/Instrument

The microprocessor revolution has accelerated technological advancements in instrumentation. The instrumentation on the Long-EZ has been upgraded continuously to keep pace with instrument technology. Improved instrumentation is installed as it becomes available or is found desirable. Typically, several instruments change each year. The following table lists the instruments, manufacturer, location, sampling rate, accuracy, resolution, and units of the instruments that were onboard during BOREAS IFCs.

<u>Variable</u>	Name	Manufacture/Model	Loc/Hz	Acc/Res	<u>Unit</u>
Acceleration	Ax	Sundstrand/QA-700	P/40	25/10	m/s^2
Acceleration	Ay	Sundstrand/QA-700	P/40	50/35	m/s^2
Acceleration	Az	Sundstrand/QA-700	P/40	70/50	m/s^2
Pressure	Px	SenSym/SCX01	P/40	70/0.6	mb
Pressure	Py	SenSym/SCXL004	P/40	50/0.5	mb
Pressure	Pz	SenSym/SCXL004	P/40	50/0.5	mb
Dif Stc Pres	DelP	SenSym/SCXL004	P/40	50/0.5	mb
Static Pres	StP	Setra/270 (mod)	H/1	0.5/0.01	mb
Attitude	Pitch	TANS VECTOR-Trimble	C/1	0.08/	deg
Attitude	Roll	TANS VECTOR-Trimble	C/1	0.08/	deg
Attitude	Head	TANS VECTOR-Trimble	C/1	0.05/	deg
Position	Lat	DGPS	P/1	3/3	deg
Position	Lng	DGPS	P/1	3/3	deg
Fast temp	Tp	ATDD/u-bead thermistor	P/40	0.1/0.005	$^{\circ}$ C
Mean temperature	Мp	RPT/Hy-Cal BA-507-B	P/1	0.05/0.03	$^{\circ}$ C
Dewpoint temp	Τď	EG&G/	C/1	0.5/0.006	$^{\circ}$ C
Water vapor	fast	ATDD/IRGA	H/40	/22	g/m^3
Water vapor	ref	LI_COR/6262	C/1	1%/0.005	mM/M
CO_2	fast	ATDD/IRGA	H/40	/0.2	mg/m^3
CO_2	ref	LI-COR/6262	C/1	<1/0.2	$\mu M/M$
O_3	fast	ATDD/Chemiluminescence	C/40	/	ppb
O_3	ref	Modified TECO	/	/	ppb

Notes: Sensor locations: P - in pressure sphere;

H - on probe hatch mountcover;

C - Aircraft CG

4.2 Calibration

All instruments were calibrated before and after each IFC. Complex instruments (such as CO₂ and O₃) were calibrated daily. All instruments undergo a comprehensive pre- and post-flight check for correct operation. The first and last data file for each flight go through a quality assurance (QA) procedure prior to the next flight. As part of the QA, takeoff and landing meteorological data are checked against conditions observed at the airport. Additionally, all data undergo time-series display, statistical and spectral analysis, and preliminary data reduction as part of the QA procedure.

4.2.1 Specifications

Not available.

4.2.1.1 Tolerance

Not available.

4.2.2 Frequency of Calibration

All instruments were calibrated before and after each IFC. Daily calibrations were performed on the CO₂ and O₃ instruments.

4.2.3 Other Calibration Information

See Section 17 (References).

5. Data Acquisition Methods

Data were collected during IFCs 1, 2, and 3 under flight conditions outlined in the BOREAS Flight Plans for flux aircraft.

6. Observations

6.1 Data Notes

None.

6.2 Field Notes

25 May 1994 Flight hours 4.4 (Hobbs) Pilot: TLC

SUMMARY: Today's flight consisted of low-level agriculture runs in the SSA with entry in the western corridor, combined with a site specific asterisk pattern over Tower 5 (Old Jack Pine).

WEATHER: Mostly clear and sunny. TAKEOFF: 1744Z, FSS Temp = 7.9 C, Dew Pt = 6.6 C

LANDING: 2045Z

NOTES: On ground met readings prior to flight: P = 969.1 mb, T = 25.9 C, Tw = 19.4 C NOTE: the on ground pre-flight T and Tw readings are probably wrong, due to a problem with the psychrometer. On ground met reading after the flight: P = 968.0 mb, T = 19.0 C, Tw = 13.7 C.

After flight: 1515 local time, zeroing LI-COR. Li-COR calibration with U.Wyo gases: H_2O : 0.45; CO_2 : -1.8, so zero is real close to where it should be. Current pot settings are 2.4 (CO_2) and 5.0 (H_2O).

26 May 19944.4 Flight Hours (Hobbs) Pilot: TLC

SUMMARY: 2 profiles & 5 Candle lake runs at 20 m--very turbulent with strong wind. Note: The NCAR Electra flew the Candle Lake line during the same period from 100 m to above the boundary layer.

WEATHER: Started clear with 15% Cu building by mid run, some high stratus

TAKEOFF: 1550Z, FSS Temp 19.3 C; Dew Pt 7.0 Wind; 180/15 LANDING: 2000Z, FSS Temp 22.3 C; Dew Pt 6.1; Alt 29.84

NOTES: On ground met readings prior to flight: T=20 C, Tw=16.9 C, P=963.4 mb After flight met

readings: T=22.3 C, Tw=13.3 C, P=961.3 mb

26 May 1994 Flight hours 1.9 (Hobbs) Pilot: EJD

SUMMARY: Flight plan was to fly a site specific, asterisk over the Old Aspen (OA) site in the

SSA.****NO GYROS FOR THE WHOLE FLIGHT****

WEATHER: Mostly sunny, some clouds around, windy

TAKEOFF: 2030Z LANDING: 2220Z

NOTES: On ground met readings prior to flight: T=22.3 C, Tw=13.3 C, P=961.3 mb

After flight met readings: T=22.5 °C, Tw=12.7 °C, P=960.2 mb.

Note: When processing data after the flight, it appears the gyros were OFF for the entire flight - not malfunctioning. Also, the ozone inlet came off sometime during the flight.

27 May 1994 4.3 Flight Hours (Hobbs) Pilot: TLC

SUMMARY: Two site specific runs - asterisks over the Black Spruce Tower, then one over the Old Jack Pine tower. CO₂ sensor was calibrated prior to flight.

WEATHER: On Takeoff, clear wx conditions - haze to East no clouds directly above, thin high stratus. Basically clear all day, with stratus building and coming in from the west at about 2000Z - 50%, from morning of about 15%. Note: BS not a good place for a site specific - there is a lot of heterogeneity: lot of little lakes, lot of chopped up stuff - lot of terrain - looking for the best direction that offers a good comparison with the tower. OJP coordinated from Piers 53.916N, 104.69W.

TAKEOFF: 1630Z FSS Temp 22 C

LANDING: 2030

NOTES: On ground met readings prior to takeoff: T=21.6 C, Tw=15.2 C, P=954.7 mb

After flight met readings: T=28 C, Tw=15.4 C, P=952.4

29 May 1994 Flight hours 2.8 (Hobbs) Pilot: TLC

SUMMARY: An OJP site asterisk plan was flown. In conjunction, the Twin Otter was flying an "L" pattern across all tower sites, and the NASA helicopter took measurements in the same area. CO2 IRGA calibration was done prior to flight, so there is an updated zero and span available. Additionally, the probe temperature sensor was changed from the glass microbead to the wire microbead; therefore, the zero and span of the temperature probe has changed.

WEATHER: Overcast most of the day. At P.A.: cloud est to be 3200 Sct, 9000Bkn, 25000 Bkn, vis 15 miles. It was more cloudy to the southwest when over the site. At landing, a system had moved in from the south, and lite precipitation had begun.

TAKEOFF: 1740Z LANDING: 2020Z

NOTES: The date and time were set incorrectly, so the first file has the wrong time. The GPS reset the time when the file was closed. he date had been 27 May, (edited after the flight).

31 May 1994 Flight hours 5.4 hours (Hobbs) Pilot: TLC

SUMMARY: The flight plan consisted of an intercomparison with the Canadian TO to the grid where the TO was to sample. After that, the Long-EZ flew 7-Candle Lake runs. The NCAR Electra also flew the Candle Lake run.

WEATHER: Clear in the morning, small cumulus by mid-morning, with increasing cloud cover by mid-afternoon. Maximum coverage 25% by the afternoon. Note: No ozone instruments installed (fast or slow). Repaired DelP sensor. "Hell-hole" access taped up, trying to reduce pressure in cabin to better ventilate the temperature probe.

TAKEOFF: 1615Z FSS Temp = 16.6 C, Dew Pt = 7.1 C, winds 300/5, alt 30.11 LANDING: 2120Z

1 June 1994 Flight hours 5.1 hours (Hobbs) Pilot: TLC

SUMMARY: Flight plan consisted of asterisks first over BS and OJP, then a Candle Lake run with the Twin Otter for intercomparison, followed by an asterisk over Old Aspen.

WEATHER: Initially clear (0800L), then clouding over by mid-morning to noon. By landing, the sky was 90% coverage. Calibration of IRGA recorded to disk prior to flight - 3 concentrations: 301.5, 365.8, 415 ppm. Also, radar altimeter failed on the last few files of the prior flight. And, there are no Magellan or ozone instruments.

TAKEOFF: 1445Z FSS Temp=18.2, Dew Pt = 7.6, alt 30.14, winds 120/10

LANDING: 2000Z

1 June 1994 Flight hours 2.6 (Hobbs) Pilot: EJD

SUMMARY: Flight plan was an asterisk over the Old Aspen site, then a few low passes over the Black Spruce site (for the press). Tape recorder failed, so there are no inflight remarks.

2 June 1994 Flight hours 1.1 hours (Hobbs) Pilot: EJD

SUMMARY: Purpose of flight was to do a pitch and wind cal at constant altitude, i.e., speed

ups/downs, wind box, wind circle. WEATHER: Overcast, lite precip.

TAKEOFF: 1450Z

LANDING: 1550Z FSS T = 17, Dew Pt = 8

4 June 1994 Flight hours 2.2 (Hobbs) Pilot: TLC

SUMMARY: This was a calibration, wind box, wind circle, speed pitch up/dn flight. The radar altimeter is back up and working fine. The ozone instruments are still out.

WEATHER: Calm, stable condition. The winds are very light and out of the NE. The haze from the paper plant was in the area, and some crud clouds were in the south. By landing, it was starting to clear out...minor wind shift.

TAKEOFF: 1200Z FSS Temp = 9.4, Dew pt = 9.2, alt 29.89, winds calm

LANDING: 1400Z FSS Temp = 15., Dew pt = 12., alt 29.89, winds calm

NOTES: Notes on landing: looking at paper mill, the winds seem to be 210 deg at the surface, then about 230 deg aloft.

4 June 1994 Flight hours 4.5 (Hobbs) Pilot: TLC

SUMMARY: Candle Lake runs coupled with an intercomparison with the Wyoming King Air.

WEATHER: Clear, calm, and mostly sunny. Some cumulus forming.

TAKEOFF: 1500Z FSS T = 16.8, Td = 11.9, winds calm, alt 29.89

LANDING 1930Z FSS T = 22.7, Td = 9.6

NOTES: Magellan GPS not working all morning. The ozone instruments are out.

4 June 1994 Flight hours 2.8 (Hobbs) Pilot: EJD

SUMMARY: Originally there was to be an asterisk to be done over OJP; however, it was precipitating over the site, so an asterisk was done over the Black Spruce site.

WEATHER: By mid-afternoon, there was about 50% cloud cover, mixed types, mostly Cu.

TAKEOFF: 2015Z

LANDING: 2300Z FSS T=24, Td=10

NOTES: Ozone instruments were re-installed for this flight.

6 June 1994 Flight hours 5.1 (Hobbs) Pilot: TLC

SUMMARY: The "h", "i", "j" L-shaped pattern was flown today. The KA was going to be flying the same pattern, and the Electra was going to be in the same vicinity. In the 2nd portion, different altitudes were flown for flux divergence measurements.

WEATHER: Some cloudiness in the early morning, coupled with ground fog progressing to approx. 50% coverage by mid-afternoon.

TAKEOFF: FSS winds 050/10, alt 29.98, T = 14.1, Td = 11.9

NOTES: During the first part of the flight, one of the switches on the gyros weren't on...after landing, the switch was turned on, ready for immediate takeoff. At approximately 1100, during flight, the alternator fuse blew, so Tim shutoff electrical power and came in. The fuse was replaced, and there was another takeoff at approximately 1215L. Same problem occurred, and the next landing was at approx. 1430L. Additionally, the ozone inlet tube came off sometime during flight, so the slow ozone data may be bad.

7 June 1994 Flight hours 4.3 (Hobbs) Pilot: TLC

SUMMARY: Candle Lake runs - the only one of the BOREAS Airforce out there

WEATHER: Windy, warm, blue skies with cirrus to the south.

TAKEOFF: 1440Z FSS Alt 30.06, winds 090/15

LANDING: 1850Z

NOTES: Ozone inlet tube came off sometime during flight yesterday...repaired for today's flight. Before flight, glycol mixed with ethyl alcohol was added to the fast-response ozone instrument. During flight, TLC noted that the fast sensor #1 was over sensitive, but that fast sensor #2 seemed OK. Also prior to flight, there was a calibration done on the fast ozone with the new solution, and there was a calibration on the CO₂ instruments with the 3 concentrations.

7 June 1994 Flight hours 3.4 (Hobbs) Pilot: EJD

SUMMARY: Candle Lake runs

WEATHER: Very windy, clear, cirrus to the south.

TAKEOFF: 2000Z Alt 30.02 FSS Winds 090/15G20 T=21.

LANDING: 2330Z FSS T=22.6, TD=-1.0

Note: The fast ozone sensors ran out of solution sometime during flight.

8 June 1994 Flight hours 4.7 (Hobbs) Pilot: TLC

SUMMARY: Asterisk pattern around Old Jack Pine - first counterclockwise in 15 deg increments, then counterclockwise in 15 deg increments.

WEATHER: On site, initially clear with cirrus aloft, then gradual increasing cloudiness. Winds along the path were approx 10 m/s.

TAKEOFF: 1530Z FSS T=15.5, Td=6.4, Alt 29.99, winds 120/10

LANDING: 1930Z FSS T=18.7, Td=11.3, winds 230/5

NOTES: In-line filter installed on Li-COR 6262 this morning - trying to mitigate pollen problems. CO₂ and ozone calibration done prior to flight, and in between flights. No TANS pseudo ranges during flight.

8 June 1994 Flight hours 2.5 (Hobbs) Pilot: EJD

SUMMARY: OJP asterisks

WEATHER: Overcast to the south, mostly clear to the north.

TAKEOFF: 2015Z FSS T = 18.8 C, Td = 11.5 C, winds 190/10, Alt 29.97 LANDING: 2230Z FSS T = 18.4 C, Td = 10.2 C, winds 210/5, Alt 29.97

Notes: Solution on fast response ozone sensors ran out during flight.

10 June 1994 Flight hours 5.6 (Hobbs) Pilot: TLC

SUMMARY: This flight was an asterisk over the Old Aspen site, and then 5 runs along the Candle Lake transect.

WEATHER: Clear in the morning (0800 or so), some ground haze - then by mid-morning, there was alto-status mixed with cirrus and some small Cu. By mid-afternoon the wind increased, and the stratus and cirrus had dissipated, and small Cu covered about 25-30% of the sky.

TAKEOFF: 1445Z FSS T = 17.3, Td = 7.9 (jumped to 8.3 while he was talking) winds 300/10, Alt 29.98

LANDING: 2030 FSS T = 22.4, Td = 8.1

NOTES: Adj offset on both the fast ozones. Also a CO₂ cal done

10 June 1994 Flight hours 3.3 (Hobbs) Pilot: EJD

SUMMARY: On this flight, a figure 8 pattern was flown over the Old Jack Pine site.

WEATHER: Mostly clear - Cu hum.

TAKEOFF: 2030Z FSS T = 22.2, Td = 7.8LANDING: 2355Z FSS T = 23.3, Td = 5.9

Note: On landing, the program had an overflow error message.

11 June 1994 Flight hours 4.8 (Hobbs) Pilot: TLC

SUMMARY: The h, i, j "L" pattern was flown, coupled with circles at various altitudes over Old Jack Pine.

WEATHER: Cu building throughout the flight (10% coverage at the beginning, ending with about 40% coverage). Areas of lite precip around the OJP site.

TAKEOFF: 1610Z FSS T = 18.2, Td = 9.5, winds 300/5

LANDING: 2015Z FSS T = 20.8, Td = 9.4, winds 290/5 to 10

NOTES: Original takeoff was at 0900L - TANS didn't come up, so TLC landed and reloaded vectors and rebooted the top board.

12 June 1994 Flight hours 1.0 (Hobbs) Pilot: EJD

SUMMARY: Pitch cal

WEATHER: 30-40% coverage of small Cu congestus

TAKEOFF: 1230Z winds 290/5, Alt 29.68 T = 11.7, Td = 9.3 Landing: 1315Z T = 12.8, Td = 9.7

NOTES: Weight = 1397.3 lbs; CG = 101.48 in. No ozone or CO₂ for this flight.

12 June 1994 Flight hours 3.7 (Hobbs) Pilot: EJD

SUMMARY: The original plan called for Figure 8s over OJP; however, there was bad weather in the area, so EJD landed and discussed an alternate plan. The decision was then to do the Old Aspen site. Figure 8s and 'Ls' were done over that site.

WEATHER: Cu building - clouds and rain over the area - mixed bag of weather

TAKEOFF: 1500Z (1st), 1615Z (2nd) FSS winds 330/5, Alt 29.68

LANDING: 1600Z (lst), 1845Z (2nd) FSS T=17.3, Td=8.6, winds 360/5G10, Alt 29.68

NOTE: ***Gyros were off for whole flight***

12 June 1994 Flight hours 2.3 (Hobbs) Pilot: TLC

SUMMARY: Figure eights over Old Jack Pine

WEATHER: Building Cu throughout the flight...no precip for most of the time, some light precip near the end.

TAKEOFF: 1915Z FSS T=17.2, Td=8.6

LANDING: 2100Z

NOTESs: \pm 2.5 nm around the tower has similar surface use as the tower -the rest is choppy and dissimilar (TLC in-flight note). Flight was terminated early because the data system 'crashed'.

*****GYROS WERE OFF THE WHOLE FLIGHT****

20 July 1994 Flight time 5.1 hr (Hobbs) Pilot: TLC

SUMMARY: Pre-Test flight, 2 PRO's and 7 Candle Lake transects. Both the Electra and King Air flew the CL transects at the same time. Fast and slow O₃ sensors installed after significant improvements between IFC1-2. Now believed to be working.

WEATHER: Lots of rain last few days. Forest fires have reduced visibility to about 5 miles. The wind is from the north @10 kts. At 1600 Cu started to build. During the day buildup continued at a slow but persistent rate to around 50% by the end of the flight.

PROBLEM - Flux gate had compass failed, now removed. Some GPS ground station data lost around noon. The NET did not work this flight due to a bad connection which was repaired after the flight. File 07201834 had an unreadable block. On test flight the gyro 10A fuse blew. It was replaced with a 12A. Does this indicate a future problem?

NOTES: Average site altitude is about 1900 msl. The gyro was cleaned before this flight to remove data "spikes".

21 July 1994 Flight time 5.1 hours (Hobbs) Pilot: EJD

SUMMARY: 1 Pitch Cal, 7 Candle Lake transects, 1 Profile. Both the Twin Otter and King Air flew the grid transects at the same time.

WEATHER: Excellent visibility today. No Cu in the morning, built to less than 10% in the afternoon. Wind calm initially, picked up considerably in the afternoon. Turbulence very light in the morning picked up considerably in the afternoon.

PROBLEM - No problems noted during flight. All instruments seemed to work well.

21 July 1994 Flight time 3.8 hours (Hobbs) Pilot: TLC

SUMMARY: 2-PRO's, 2 complete and 2 short Candle Lake transects. The last CL transect was flown with the TO. Flight direction was to west. At Candle lake, the flight speed was reduced from 120 kts to 110 kts. FE also flew the transect but ahead of FL & FT. This was a "golden day" with 16 flights! WEATHER: Clear sky all day! Winds low and from 030

PROBLEM - Data system crashed caused early mission termination.

NOTES: Since the winds are down the transect and lots of flight missions were flown, this may be a good day for "lake effects" boundary layer research.

22 July 1994 Flight time 1.7 hours (Hobbs) Pilot: EJD

SUMMARY: 2 Pitch Cals, 1 Candle Lake transect. Late evening, not much activity.

WEATHER: Clear over YPA, high clouds over CL transect. Very little turbulence on CL run.

PROBLEM - No problems noted during flight. All instruments seemed to work well.

23 July 1994 Flight time 4.7 hours (Hobbs) Pilot: TLC

SUMMARY: 2-PRO's and 6 Candle Lake transects. The last CL transect was flown with the FK which operated at 200 AGL and 3500 MSL. FT also flew the CL transect during transition from SS-OA to SS-OBS & OJP.

WEATHER: Flight started with clear skies but small Cu developed from delta to alpha. By the end of the flight, the Cu was 60% at delta and 10% at alpha. The wind was 330 at ?

PROBLEM - The O3 sensors were removed for this and all future flights. The last two flights should have had good O3 data.

23 July 1994 Flight time 2.6 hours (Hobbs) Pilot: EJD

SUMMARY: 2-PRO's and OJP site specific.

WEATHER: Flight started with cloudy skies > 50% cloud cover. Turbulence was extremely rough. Terminated flight early due to extreme turbulence.

24 July 1994 Flight time 5.2 hours (Hobbs) Pilot: TLC

SUMMARY: 2-PRO's and 9 FLX L's under clear sky & light North winds. The FT& FK flew the "Grid" during this flight.

WEATHER: Clear all day! Winds light and from the north.

24 July 1994 Flight time 4.5 hours (Hobbs) Pilot: EJD

SUMMARY: 2-PRO's and 8 FLX L's under clear sky & light North winds. The FT flew the L's at the same time as N3R.

WEATHER: Clear all day! Winds light and from the north. Some turbulence early in flight, decaying toward the end.

25 July 1994 Flight time 6.6 hours (Hobbs) Pilot: TLC

SUMMARY: Golden day #2. 2-PRO's and 9 CL FLX's under clear sky & calm winds. The FT worked site specifics while FK did CL at 200 AGL & 3500 MSL. There are two flights where FT and FK were on the same transect at close to the same time.

WEATHER: Clear all day! Winds very light and from the north. Winds a little stronger to the east. PROBLEM - Channel 4 power controller, which powers the gyros, blew a second fuse. We are now running with a 14A fuse in this channel. Power channels 2 & 3 are not working correctly. They were disabled and bypassed with a switch. The dew point has shown some problems on previous flights. The mirror was cleaned before this flight. Audio flight notes were lost during last half of flight.

26 July 1994 Flight time 4.9 hours (Hobbs) Pilot: EJD

SUMMARY: Golden day #3. 1-Pitch cal, 1 PRO, and a bunch of OAS FLX's under clear sky & calm winds.

WEATHER: Clear all morning! Winds very light and from the southwest.

PROBLEM - No equipment problems noted. All sensors appeared to be working well.

26 July 1994 Flight time 4.5 hours (Hobbs) Pilot: TLC

SUMMARY: 2-PRO's and 2 OJP asterisk under clear sky & calm winds. WEATHER: Clear all day! Winds very light. Thin smoke/haze layer at ~8000.

27 July 1994 Flight time 1.0 hour (Hobbs) Pilot: EJD

SUMMARY: 1 Takeoff file, 1 Pitch cal, 1 river climb, 1 touch & go.

WEATHER: Haze layer at 4000' during Pitch cal. Clear otherwise. PROBLEM - No equipment problems noted. All sensors appeared to be working well.

27 July 1994 Flight time 5.9 hours (Hobbs) Pilot: TLC

SUMMARY: 2-PRO's and 5 FLX E-W grids under clear sky & low southerly winds.

WEATHER: Clear all day however there is a lot of smoke and haze! Winds light.

PROBLEM - MFP clock set one day behind. All data files corrected. The last file, which included a PRO, TXI and STC, and its associated markers were lost.

NOTES: NSA is now the "hot" site; other aircraft operating in N. The IRGA was cleaned before the flight.

28 July 1994 Flight time 5.8 hours (Hobbs) Pilot: EJD

SUMMARY: 2 PRO's and 8 Candle Lake flux runs under clear sky initially, rapid buildup of Cu to approx 40% for last 2 FLX runs. WEATHER: Clear sky for first 4 hours, last 2 hours rapid buildup of approx 40% Cu and a thunderstorm near d on last FLX run.

29 July 1994 Flight time 4.1 hours (Hobbs) Pilot: TLC

SUMMARY: 2 PRO's and 5 CL FLX under unsettled (variable cloud and some rain) conditions. WEATHER: Front passing through with associated unsettled conditions. Low small Cu (2000-2500) generated by overnight rain. Stratus at 12000. Winds are calm.

29 July 1994 Flight time Pilot: EJD

SUMMARY: 17 legs of Fig 8 pattern at Old Aspen

WEATHER:

30 July 1994 Flight time Pilot: EJD SUMMARY: 8 Candle Lake Flux transects

30 August 1994Flight hours 2.1 (Hobbs)

SUMMARY: Shakedown flight - some problems encountered, i.e. no angles on first flight, but after rebooting the top card and reloading the antennae vectors, everything with respect to the TANS was up and operating correctly. On the last attempt, however, the gyros were not on.

WEATHER: Mostly cloudy all day, with intermittent, moderate rain. Conditions were not conducive for any good Candle Lake transects, or any site specific work.

NOTES: The Tp and Th pots were adjusted today, because the Tp was offscale low. The Th pots were accidentally adjusted (thinking they were the Tp's), but they were turned back and both the Tp and the Th look good now.

31 August 1994 Flight time 5.8 hours (Hobbs)

SUMMARY: Candle Lake transects

WEATHER: Clear in the morning (up to about 10 a.m. local), then small Cu for the remainder of the day (coverage about 25%)

1 September 1994 Flight time 6.2 hours (Hobbs)

SUMMARY: Candle Lake transects.

WEATHER: Clear in the morning, with Cu building around noon. Coverage was no more than 25%. By 1600L, most of the Cu had dissipated - coverage reduced to about 10% - more to the North. On the transects there was Cu and haze.

3 September, 1994 Flight time 4.4 hours (Hobbs)

SUMMARY: Buttonhole patterns over Old Jack Pine. Ground tracks of 030 and 210 deg.

WEATHER: Overcast on site for whole flight. Moderate to strong crosswind.

5 September 1994 Flight time 5.0 hours (Hobbs)

SUMMARY: Buttonhole patterns at Old Jack Pine and Black Spruce.

WEATHER: Clear and calm for takeoff, then around noon the clouds began to form and the winds picked up significantly. Along the flight path, it was turbulent and windy.

NOTE: Ozone filter came off sometime during flight

6 September 1994 Flight time 6.2 hours (Hobbs)

SUMMARY: Candle Lake transects

WEATHER: Clear and calm on takeoff. Winds increased and changed directions in the early afternoon. Sky was clear all day with the exception of a few small Cu to the northeast (less than 5% coverage). There was a gradual wind shift at P.A. throughout the day.

NOTES: Ozone filter came off sometime during flight (again).

7 September 1994 Flight A Flight time 4.4 hours (Hobbs)

SUMMARY: 18 runs by OJP

WEATHER: Overcast in the morning with cirrus, clearing by mid-morning but with some cirrus still.

7 September 1994 Flight B Flight time 3.5 (Hobbs)

SUMMARY: Buttonhole pattern around the Old Aspen site.

WEATHER: Some thin high cirrus, but basically warm and clear. Winds were 110-120 at 10 most of the day (at P.A.)

8 September 1994 Flight A Flight time 4.4 hours (Hobbs)

SUMMARY: Grid pattern.

WEATHER: Clear, dry, warm, no wind.

8 September 1994 Flight B

SUMMARY: Grid patterns

WEATHER: Clear, dry, warm, almost no wind

9 September 1994 Flight time 3.4 hours (Hobbs)

SUMMARY: Buttonhole patterns over Old Jack Pine

WEATHER: Overcast with cirrus, slight wind, warm and humid

11 September 1994 Flight time 5.4 hours (Hobbs)

SUMMARY: Candle Lake transects

WEATHER: Started out cloudy, then cleared in the P.A. area. Cool day. EJD said the Candle Lake transect was overcast.

NOTES: Time of flight needs fixing. When the data system was started, the computer clock showed 1536 and the GPS showed 1618.

12 September 1994 Flight time 4.8 hours (Hobbs)

SUMMARY: Old Jack Pine and Old Aspen buttonhole patterns

WEATHER: The day started out overcast and rainy, but around 1030L, it started to clear; then Cu started to form around noon. Cloud cover remained around 25% in the P.A. area.

NOTES: Computer time and GPS time were different by about 45 min. (GPS was 1738, computer was 1654.

13 September 1994 Flight time 5.0 hours (Hobbs)

SUMMARY: Site specific work over Old Black Spruce to coordinate with Larry Mahrt. Then over to Old Jack Pine to allow Canadian TV to film some flybys.

WEATHER: Clear in the P.A. area until noon, then cirrus. Over the OBS it was clear except for some cirrus, and over Old Jack Pine, basically clear conditions. NOTE: TIMES ARE WRONG!!

15 September 1994 Flight time 3.4 hours (Hobbs)

SUMMARY: IC with the Twin Otter over the Old Aspen site, then a couple of Candle Lake transects, and a pitch cal.

WEATHER: Started out with some clouds, gradually cleared. By 1430 (local) the sky had less than 5% coverage of small Cu, with some cirrus.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

Candle Lake transects covered an approximate 100-km transect; one pass by a tower was approximately 12 km; a grid leg was approximately 15 km; the "L" pattern ranged from 100 to 200 km.

The Long-EZ aircraft covered sites in the SSA. The North American Datum of 1983 (NAD83) corner coordinates of the SSA are:

	Longitude	Latitude
Northwest	106.228° W	54.321° N
Northeast	104.237° W	54.225° N
Southwest	106.321° W	53.515° N
Southeast	104.368° W	53.420° N

The tower sites in the SSA include:

Site	Longitude		Latitude		BOREAS X	BOREAS Y
OBS	105.11779°	W	53.98717°	Ν	385.012	348.646
OJP	104.69203°	W	53.91634°	N	413.526	343.226
Young Jack Pine (YJP)	104.64529°	W	53.87581°	N	416.988	339.008
Fen	104.61798°	W	53.80206°	N	419.527	330.991
OA	106.19779°	W	53.62889°	N	317.198	303.403

7.1.2 Spatial Coverage Map

None.

7.1.3 Spatial Resolution

The spatial resolution of the original data used in the flux computations is a function of the aircraft speed (50 m/s) and the digital recording rate (40 Hz). This translates to a basic sampling resolution of approximately 1 m for the Long-EZ. However, there is significant natural geophysical variability associated with any turbulence measurement. As a result, statistically significant covariance flux measurement requires space- or time-averaging. The reported data values represent 3-km averages. The basis for the utility of this short average is the Long-EZ's low flight altitude and fast-response data system. The size of flux-transporting turbulence structure decreases (i.e., frequency increases) as the measurement altitude is reduced. This tends to reduce the importance of intermittency, which adversely affects measurements made at higher altitudes.

7.1.4 Projection

Not applicable.

7.1.5 Grid Description

Not applicable.

7.2 Temporal Characteristics

These data were collected during the BOREAS IFCs in 1994. The range of dates is from 25-May to 15-Sep-1994.

7.2.1 Temporal Coverage

There were typically two or three flights per day, with 4-5 hour duration each. The days during which data were collected are:

Flight Dates	Flight Dates	Flight Dates
25-May-1994	20-Jul-1994 21-Jul-1994	31-Aug-1994
26-May-1994 27-May-1994	22-Jul-1994	01-Sep-1994
29-May-1994	23-Jul-1994	03-Sep-1994
31-May-1994	24-Jul-1994	05-Sep-1994
	25-Jul-1994	06-Sep-1994
01-Jun-1994	26-Jul-1994	07-Sep-1994
04-Jun-1994	27-Jul-1994	08-Sep-1994
06-Jun-1994	28-Jul-1994	09-Sep-1994
07-Jun-1994	29-Jul-1994	11-Sep-1994
08-Jun-1994	30-Jul-1994	12-Sep-1994
10-Jun-1994 11-Jun-1994		13-Sep-1994 15-Sep-1994

7.2.2 Temporal Coverage Map

None.

7.2.3 Temporal Resolution

The aircraft data were digitized at 200 Hz to allow an oversampling factor of five before recording at 40 Hz.

7.3 Data Characteristics

7.3.1 Parameter/Variable

The parameters contained in the data files on the CD-ROM are:

Column Name ______ SPATIAL COVERAGE RUN START DATE RUN_START_TIME RUN END DATE RUN_END_TIME FLUX MISSION DESIGNATOR FLUX_MISSION_NUM FLUX_PASS_NUM FLUX_SEGMENT_NUM START_LATITUDE START LONGITUDE END LATITUDE END LONGITUDE START_BOREAS_X START_BOREAS_Y END BOREAS X END BOREAS Y **HEADING** MEAN PRESS ALTITUDE MEAN_RADAR_ALTITUDE MEAN_WIND_DIR MEAN WIND SPEED MEAN AIR TEMP MEAN POTNTL TEMP MEAN_H2O_MIX_RATIO MEAN_U_COMPNT_WIND_VELOC MEAN_V_COMPNT_WIND_VELOC MEAN STATIC PRESS MEAN_SURF_RAD_TEMP MEAN_DOWN_TOTAL_RAD MEAN_UP_TOTAL_RAD MEAN_DOWN_LONGWAVE_RAD MEAN UP LONGWAVE RAD MEAN_NET_RAD MEAN UP PPFD MEAN_DOWN_PPFD MEAN_AUX_RAD MEAN_GREEN_INDEX MEAN CO2 CONC

MEAN_O3_CONC

MEAN CH4 CONC

MEAN_SAT_SIM_CH1

MEAN_SAT_SIM_CH2

MEAN SAT SIM CH3

MEAN SAT SIM CH4

SDEV_AIR_TEMP

SDEV POTNTL TEMP

SDEV_H2O_MIX_RATIO

SDEV U COMPNT WIND VELOC

SDEV_V_COMPNT_WIND_VELOC

SDEV STATIC PRESS

SDEV_SURF_RAD_TEMP

SDEV_DOWN_TOTAL_RAD

SDEV UP TOTAL RAD

SDEV DOWN LONGWAVE RAD

SDEV UP LONGWAVE RAD

SDEV_NET_RAD

SDEV UP PPFD

SDEV_DOWN_PPFD

SDEV AUX RAD

SDEV_GREEN_INDEX

SDEV_CO2_CONC

SDEV_O3_CONC

SDEV_CH4_CONC

SDEV SAT SIM CH1

SDEV SAT SIM CH2

SDEV SAT SIM CH3

SDEV_SAT_SIM_CH4

TREND AIR TEMP

TREND_POTNTL_TEMP

TREND H2O MIX RATIO

TREND_U_COMPNT_WIND_VELOC

TREND V COMPNT WIND VELOC

TREND_STATIC_PRESS

TREND_SURF_RAD_TEMP

TREND DOWN TOTAL RAD

TREND_UP_TOTAL_RAD

TREND_DOWN_LONGWAVE_RAD

TREND_UP_LONGWAVE_RAD

TREND GREEN INDEX

TREND_CO2_CONC

TREND 03 CONC

TREND_CH4_CONC

SDEV_VERT_GUST_RAW

SDEV_U_COMPNT_WIND_VELOC_RAW

SDEV_V_COMPNT_WIND_VELOC_RAW

SDEV_ALONG_WIND_RAW

SDEV_CROSS_WIND_RAW

SDEV POTNTL TEMP RAW

SDEV_H2O_MIX_RATIO_RAW

SDEV CO2 MIX RATIO RAW

SDEV_O3_CONC_RAW

SDEV CH4 CONC RAW

SKEW_VERT_GUST_RAW

SKEW_U_COMPNT_WIND_VELOC_RAW

SKEW_V_COMPNT_WIND_VELOC_RAW

SKEW ALONG WIND RAW

SKEW_CROSS_WIND_RAW

SKEW POTNTL TEMP RAW

SKEW_H2O_MIX_RATIO_RAW

SKEW CO2 MIX RATIO

SKEW_O3_CONC_RAW

SKEW CH4 CONC RAW

KURT VERT GUST RAW

KURT_U_COMPNT_WIND_VELOC_RAW

KURT_V_COMPNT_WIND_VELOC_RAW

KURT_ALONG_WIND_RAW

KURT CROSS WIND RAW

KURT POTNTL TEMP RAW

KURT H2O MIX RATIO RAW

KURT_CO2_MIX_RATIO_RAW

KURT O3 CONC RAW

KURT_CH4_CONC_RAW

CORC VERT U WIND COMPNT RAW

CORC_VERT_V_WIND_COMPNT_RAW

CORC_VERT_ALONG_WIND_RAW

CORC_VERT_CROSS_WIND_RAW

CORC_VERT_POTNTL_TEMP_RAW

CORC_VERT_H2O_MIX_RATIO_RAW

CORC VERT CO2 MIX RATIO RAW

CORC VERT O3 CONC RAW

CORC_VERT_CH4_CONC_RAW

CORC_POTNTL_H2O_MIX_RATIO_RAW

MMNTM_FLUX_V_WIND_COMPNT_RAW

MMNTM_FLUX_U_WIND_COMPNT_RAW

MMNTM_FLUX_ALONG_MEAN_WIND_RAW

MMNTM FLUX CROSS MEAN WIND RAW

SENSIBLE HEAT FLUX RAW

LATENT_HEAT_FLUX_RAW

CO2 FLUX RAW

O3_FLUX_RAW

O3_DEPOSITION_VELOC_RAW

CH4_FLUX_RAW

AIR DENSITY CONSTANT

SPECIFIC_HEAT_CONSTANT

LATENT HEAT VAP CONSTANT

DRY AIR GAS CONSTANT

SDEV VERT GUST DET

SDEV_U_COMPNT_WIND_VELOC_DET

SDEV_V_COMPNT_WIND_VELOC_DET

SDEV_ALONG_WIND_DET

SDEV CROSS WIND DET

SDEV POTNTL TEMP DET

SDEV_H2O_MIX_RATIO_DET

SDEV CO2 MIX RATIO

SDEV_O3_CONC_DET

SDEV CH4 CONC DET

SKEW_VERT_GUST_DET

SKEW_U_COMPNT_WIND_VELOC_DET SKEW_V_COMPNT_WIND_VELOC_DET SKEW ALONG WIND DET SKEW CROSS WIND DET SKEW POTNTL TEMP DET SKEW_H2O_MIX_RATIO_DET SKEW CO2 MIX RATIO DET SKEW_O3_CONC_DET SKEW CH4 CONC DET KURT VERT GUST DET KURT_U_COMPNT_WIND_VELOC_DET KURT_V_COMPNT_WIND_VELOC_DET KURT_ALONG_WIND_DET KURT CROSS WIND DET KURT POTNTL TEMP DET KURT H2O MIX RATIO DET KURT_CO2_MIX_RATIO_DET KURT O3 CONC DET KURT_CH4_CONC_DET CORC VERT U WIND COMPNT DET CORC_VERT_V_WIND_COMPNT_DET CORC_VERT_ALONG_WIND_DET CORC_VERT_CROSS_WIND_DET CORC_VERT_POTNTL_TEMP_DET CORC VERT H20 MIX RATIO DET CORC VERT CO2 MIX RATIO DET CORC VERT O3 CONC DET CORC_VERT_CH4_CONC_DET CORC POTNTL H20 MIX RATIO DET MMNTM_FLUX_U_WIND_COMPNT_DET MMNTM FLUX V WIND COMPNT DET MMNTM_FLUX_ALONG_MEAN_WIND_DET MMNTM_FLUX_CROSS_MEAN_WIND_DET SENSIBLE_HEAT_FLUX_DET LATENT_HEAT_FLUX_DET CO2 FLUX DET O3 FLUX DET O3 DEPOSITION VELOC DET CH4_FLUX_DET CRTFCN CODE REVISION_DATE

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Column Name	Description
SPATIAL_COVERAGE	The general term used to denote the spatial area
	over which the data were collected.
RUN_START_DATE	The date in GMT at the beginning of the segment
	(or pass if not segmented) in the form
	DD-MON-YY.
RUN_START_TIME	The time in GMT at the beginning of the segment
	(or pass if not segmented).

RUN_END_DATE The date in GMT at the end of the segment (or pass if not segmented) in the form DD-MON-YY. The time in GMT at the end of the segment (or RUN END TIME pass if not segmented). FLUX MISSION DESIGNATOR The two-letter mission identifier used to identify the type of mission being flown, where GS or GN=grids and stacks, CS=Candle Lake runs, TS or TN=site-specific runs, RT=transects, LS or LN=mini- or meso-transects, PS or PN=Budget Box pattern, HS or HN=stacks and tees, FS or FN=flights of two for intercomparison, ZS=lowlevel routes, and XX=not standard. FLUX_MISSION_NUM The sequential number for all missions flown on a given day starting at 1. FLUX PASS NUM The sequential pass number within a mission starting at 1. FLUX_SEGMENT_NUM The segment number within the current pass starting at 1 or given as 0 if pass is not segmented. START LATITUDE The NAD83 based latitude coordinate at the start of the measurement set. START LONGITUDE The NAD83 based longitude coordinate at the start of the measurement set. END_LATITUDE The NAD83 based latitude coordinate at the end of the measurement set. END LONGITUDE The NAD83 based longitude coordinate at the end of the measurement set. The x component of the BOREAS grid coordinate at START_BOREAS_X the start of the measurement set. START_BOREAS_Y The y component of the BOREAS grid coordinate at the start of the measurement set. END BOREAS X The x component of the BOREAS grid coordinate at the end of the measurement set. END_BOREAS_Y The y component of the BOREAS grid coordinate at the end of the measurement set. The aircraft heading. HEADING MEAN PRESS ALTITUDE The mean pressure altitude. MEAN RADAR ALTITUDE The mean radar altitude. MEAN_WIND_DIR The mean direction from which the wind was traveling, increasing in a clockwise direction from the north for the given time over the period defined by the start and end dates. MEAN WIND SPEED The mean wind speed for the given time over the period defined by the start and end dates. MEAN AIR TEMP The mean air temperature. MEAN_POTNTL_TEMP The mean potential temperature. MEAN H2O MIX RATIO The mean water vapor mixing ratio. MEAN_U_COMPNT_WIND_VELOC The mean westerly vector component of the wind speed and wind direction. MEAN_V_COMPNT_WIND_VELOC The mean southerly vector component of the wind speed and wind direction. MEAN_STATIC_PRESS The mean static pressure. MEAN SURF RAD TEMP The mean surface radiative temperature.

The mean downwelling total radiation.

MEAN_DOWN_TOTAL_RAD

MEAN UP TOTAL RAD The mean upwelling total radiation. MEAN_DOWN_LONGWAVE_RAD The mean downward longwave radiation. MEAN UP LONGWAVE RAD The mean upwelling longwave radiation. MEAN NET RAD The mean net radiation. MEAN UP PPFD The mean upward photosynthetic photon flux density. MEAN DOWN PPFD The mean downward photosynthetic photon flux density. MEAN AUX RAD The mean measurement from the auxiliary radiation sensor. MEAN GREEN INDEX The mean greenness index. MEAN CO2 CONC The mean carbon dioxide concentration. MEAN_O3_CONC The mean ozone concentration. The mean methane concentration. MEAN CH4 CONC MEAN SAT SIM CH1 The mean channel 1 satellite simulator. The mean channel 2 satellite simulator. MEAN SAT SIM CH2 MEAN_SAT_SIM_CH3 The mean channel 3 satellite simulator. The mean channel 4 satellite simulator. MEAN_SAT_SIM_CH4 The standard deviation of the air temperature. SDEV_AIR_TEMP SDEV POTNTL TEMP The standard deviation of potential temperature. SDEV_H2O_MIX_RATIO The standard deviation of the water vapor mixing ratio. The standard deviation of the westerly vector SDEV_U_COMPNT_WIND_VELOC component of the wind speed and wind direction. SDEV V COMPNT WIND VELOC The standard deviation of the southerly vector component of the wind speed and wind direction. The standard deviation of the static pressure. SDEV STATIC PRESS SDEV_SURF_RAD_TEMP The standard deviation of the surface radiative temperature. The standard deviation of downwelling total SDEV_DOWN_TOTAL_RAD SDEV_UP_TOTAL_RAD The standard deviation of upwelling total radiation. SDEV_DOWN_LONGWAVE_RAD The standard deviation of the downward longwave SDEV UP LONGWAVE RAD The standard deviation of upwelling longwave radiation. The standard deviation of the mean net radiation. SDEV NET RAD SDEV_UP_PPFD The standard deviation of the upward photosynthetic photon flux density. SDEV_DOWN_PPFD The standard deviation of the downward photosynthetic photon flux density. The standard deviation of the measurements from SDEV AUX RAD the auxiliary radiation sensor. The standard deviation of greenness index. SDEV GREEN INDEX SDEV CO2 CONC The standard deviation of the CO2 concentration. The standard deviation of the ozone SDEV 03 CONC concentration. The standard deviation of CH4 concentration. SDEV CH4 CONC SDEV_SAT_SIM_CH1 The standard deviation of the channel 1 satellite simulator values. The standard deviation of channel 2 satellite SDEV_SAT_SIM_CH2 simulator values. SDEV_SAT_SIM_CH3 The standard deviation of channel 3 satellite

simulator values. The standard deviation of channel 4 satellite SDEV_SAT_SIM_CH4 simulator values. TREND AIR TEMP The trend in air temperature. TREND POTNTL TEMP The trend in potential temperature. TREND_H2O_MIX_RATIO The trend in water vapor mixing ratio. TREND_U_COMPNT_WIND_VELOC The trend in the westerly vector component of the wind speed and wind direction. TREND V COMPNT WIND VELOC The trend in the southerly vector component of the wind speed and wind direction. TREND STATIC PRESS The trend in static pressure. TREND SURF RAD TEMP The trend in surface radiative temperature. The trend in the downwelling total radiation. TREND_DOWN_TOTAL_RAD TREND UP TOTAL RAD The trend in the upwelling total radiation. TREND DOWN LONGWAVE RAD The trend in the downwelling longwave radiation. TREND UP LONGWAVE RAD The trend in the upwelling longwave radiation. TREND_GREEN_INDEX The trend in the greenness index. TREND_CO2_CONC The trend in the carbon dioxide concentration. The trend in the ozone concentration. TREND_O3_CONC TREND_CH4_CONC The trend in the methane concentration. The standard deviation of the raw vertical gust. SDEV VERT GUST RAW SDEV_U_COMPNT_WIND_VELOC_RAW The standard deviation of the raw westerly wind component. SDEV_V_COMPNT_WIND_VELOC_RAW The standard deviation of the raw southerly wind component. SDEV_ALONG_WIND_RAW The standard deviation of the raw along wind component. SDEV_CROSS_WIND_RAW The standard deviation of the raw cross wind SDEV_POTNTL_TEMP_RAW The standard deviation of the raw potential temperature. SDEV_H2O_MIX_RATIO_RAW The standard deviation of the raw water vapor mixing ratio. SDEV_CO2_MIX_RATIO_RAW The standard deviation of the raw carbon dioxide mixing ratio. The standard deviation of the raw ozone SDEV 03 CONC RAW concentration. The standard deviation of the raw methane SDEV CH4 CONC RAW concentration. SKEW VERT GUST RAW The skewness of the raw vertical gust. SKEW_U_COMPNT_WIND_VELOC_RAW The skewness of the raw westerly wind component. SKEW V COMPNT WIND VELOC RAW The skewness of the raw southerly wind component. SKEW ALONG WIND RAW The skewness of the raw along wind component. SKEW_CROSS_WIND_RAW The skewness of the raw cross wind component. SKEW_POTNTL_TEMP_RAW The skewness of the raw potential temperature. The skewness of the raw water vapor mixing SKEW H2O MIX RATIO RAW ratio. SKEW CO2 MIX RATIO The skewness of the raw carbon dioxide mixing ratio. SKEW O3 CONC RAW The skewness of the raw ozone concentration. The skewness of the raw methane concentration. SKEW_CH4_CONC_RAW KURT VERT GUST RAW The kurtosis of the raw vertical gust. KURT_U_COMPNT_WIND_VELOC_RAW The kurtosis of the raw westerly wind component.

KURT_V_COMPNT_WIND_VELOC_RAW The kurtosis of the raw southerly wind component. The kurtosis of the raw along wind component. KURT ALONG WIND RAW KURT CROSS WIND RAW The kurtosis of the raw cross wind component. KURT POTNTL TEMP RAW The kurtosis of the raw potential temperature. KURT_H2O_MIX_RATIO_RAW The kurtosis of the raw water vapor mixing KURT_CO2_MIX_RATIO_RAW The kurtosis of the raw carbon dioxide mixing The kurtosis of the raw ozone concentration. KURT_O3_CONC_RAW KURT_CH4_CONC_RAW The kurtosis of the raw methane concentration. CORC_VERT_U_WIND_COMPNT_RAW The correlation coefficient of the raw vertical gust/westerly wind component pair. The correlation coefficient of the raw vertical CORC VERT V WIND COMPNT RAW gust/southerly wind component pair. CORC_VERT_ALONG_WIND_RAW The correlation coefficient of the raw vertical gust/along wind component pair. CORC_VERT_CROSS_WIND_RAW The correlation coefficient of the raw vertical gust/cross wind component pair. CORC_VERT_POTNTL_TEMP_RAW The correlation coefficient of the raw vertical qust/potential temperature pair. CORC_VERT_H2O_MIX_RATIO_RAW The correlation coefficient of the raw vertical gust/water vapor mixing ratio pair. CORC_VERT_CO2_MIX_RATIO_RAW The correlation coefficient of the raw vertical qust/carbon dioxide mixing ratio pair. CORC_VERT_O3_CONC_RAW The correlation coefficient of the raw vertical qust/ozone concentration pair. CORC_VERT_CH4_CONC_RAW The correlation coefficient of the vertical gust /methane concentration pair. CORC_POTNTL_H2O_MIX_RATIO_RAW The correlation coefficient of the raw potential temperature/water vapor mixing ratio pair. MMNTM_FLUX_V_WIND_COMPNT_RAW The momentum flux using the raw southerly wind component. MMNTM_FLUX_U_WIND_COMPNT_RAW The momentum flux using the raw westerly wind component. MMNTM FLUX ALONG MEAN WIND RAW The momentum flux using the raw along mean wind component. MMNTM FLUX CROSS MEAN WIND RAW The momentum flux using the raw across mean wind component. SENSIBLE HEAT FLUX RAW The raw sensible heat flux. LATENT_HEAT_FLUX_RAW The raw latent heat flux. The raw carbon dioxide flux. CO2 FLUX RAW The raw ozone flux. O3 FLUX RAW O3_DEPOSITION_VELOC_RAW The raw ozone deposition velocity. CH4_FLUX_RAW The raw methane flux. AIR_DENSITY_CONSTANT The constant used for air density in the flux calculations. SPECIFIC HEAT CONSTANT The constant used for specific heat at constant pressure in the flux calculations. The constant used for latent heat of vaporization LATENT_HEAT_VAP_CONSTANT in the flux calculations. The dry air gas constant used in the flux DRY_AIR_GAS_CONSTANT calculations. SDEV_VERT_GUST_DET The standard deviation of the detrended vertical

gust. SDEV_U_COMPNT_WIND_VELOC_DET The standard deviation of the detrended westerly wind component. SDEV V COMPNT WIND VELOC DET The standard deviation of the detrended southerly wind component. SDEV_ALONG_WIND_DET The standard deviation of the detrended along wind component. SDEV_CROSS_WIND_DET The standard deviation of the detrended cross wind component. SDEV_POTNTL_TEMP_DET The standard deviation of the detrended potential temperature. SDEV_H2O_MIX_RATIO_DET The standard deviation of the detrended water vapor mixing ratio. The standard deviation of the detrended carbon SDEV CO2 MIX RATIO dioxide mixing ratio. SDEV_O3_CONC_DET The standard deviation of the detrended ozone concentration. SDEV_CH4_CONC_DET The standard deviation of the detrended methane concentration. SKEW VERT GUST DET The skewness of the detrended vertical gust. The skewness of the detrended westerly wind SKEW_U_COMPNT_WIND_VELOC_DET component. SKEW_V_COMPNT_WIND_VELOC_DET The skewness of the detrended southerly wind component. SKEW ALONG WIND DET The skewness of the detrended along wind component. SKEW CROSS WIND DET The skewness of the detrended cross wind component. SKEW_POTNTL_TEMP_DET The skewness of the detrended potential temperature. SKEW_H2O_MIX_RATIO_DET The skewness of the detrended water vapor mixing ratio. SKEW_CO2_MIX_RATIO_DET The skewness of the detrended carbon dioxide mixing ratio. The skewness of the detrended ozone SKEW_O3_CONC_DET concentration. SKEW CH4 CONC DET The skewness of the detrended methane concentration. KURT_VERT_GUST_DET The kurtosis of the detrended vertical gust. KURT_U_COMPNT_WIND_VELOC_DET The kurtosis of the detrended westerly wind component. KURT V COMPNT WIND VELOC DET The kurtosis of the detrended southerly wind component. KURT_ALONG_WIND_DET The kurtosis of the detrended along wind component. KURT_CROSS_WIND_DET The kurtosis of the detrended cross wind component. KURT POTNTL TEMP DET The kurtosis of the detrended potential temperature. KURT_H2O_MIX_RATIO_DET The kurtosis of the detrended water vapor mixing ratio. KURT_CO2_MIX_RATIO_DET The kurtosis of the detrended carbon dioxide mixing ratio.

The kurtosis of the detrended ozone

KURT_O3_CONC_DET

concentration. The kurtosis of the detrended methane KURT_CH4_CONC_DET concentration. The correlation coefficient of the detrended CORC_VERT_U_WIND_COMPNT_DET vertical gust/westerly wind component pair. CORC_VERT_V_WIND_COMPNT_DET The correlation coefficient of the detrended vertical gust/southerly wind component pair. The correlation coefficient of the detrended CORC_VERT_ALONG_WIND_DET vertical gust/along wind component pair. CORC_VERT_CROSS_WIND_DET The correlation coefficient of the detrended vertical gust/cross wind component pair. The correlation coefficient of the detrended CORC_VERT_POTNTL_TEMP_DET vertical gust/potential temperature pair. CORC VERT H2O MIX RATIO DET The correlation coefficient of the detrended vertical gust/water vapor mixing ratio pair. CORC_VERT_CO2_MIX_RATIO_DET The correlation coefficient of the detrended vertical gust/carbon dioxide mixing ratio pair. CORC_VERT_O3_CONC_DET The correlation coefficient of the detrended vertical gust/ozone concentration pair. CORC VERT CH4 CONC DET The correlation coefficient of the detrended vertical gust/methane concentration pair. CORC_POTNTL_H2O_MIX_RATIO_DET The correlation coefficient of the detrended potential temperature/water vapor mixing ratio pair. MMNTM FLUX U WIND COMPNT DET The momentum flux using the detrended westerly wind component. MMNTM_FLUX_V_WIND_COMPNT_DET The momentum flux using the detrended southerly wind component. MMNTM_FLUX_ALONG_MEAN_WIND_DET The momentum flux using the detrended along mean wind component. MMNTM FLUX CROSS MEAN WIND DET The momentum flux using the detrended across mean wind component. SENSIBLE HEAT FLUX DET The detrended sensible heat flux. The detrended latent heat flux. LATENT_HEAT_FLUX_DET The detrended carbon dioxide flux. CO2_FLUX_DET The detrended ozone flux. O3 FLUX DET O3_DEPOSITION_VELOC_DET The detrended ozone deposition velocity. The detrended methane flux. CH4 FLUX DET CRTFCN_CODE The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable). REVISION DATE The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files on the CD-ROM are:

Column Name	Units
SPATIAL_COVERAGE	[none]
RUN_START_DATE	[DD-MON-YY]
RUN_START_TIME	[HHMMSS GMT]
RUN_END_DATE	[DD-MON-YY]

```
RUN END TIME
                                [HHMMSS GMT]
FLUX_MISSION_DESIGNATOR
                                [none]
                                [unitless]
FLUX MISSION NUM
FLUX PASS NUM
                                [unitless]
FLUX SEGMENT NUM
                                [unitless]
START_LATITUDE
                                [degrees]
START LONGITUDE
                                [degrees]
END_LATITUDE
                                [degrees]
END LONGITUDE
                                [degrees]
START BOREAS X
                                [kilometers]
START BOREAS Y
                                [kilometers]
                                [kilometers]
END BOREAS X
END BOREAS Y
                                [kilometers]
HEADING
                                [degrees]
MEAN PRESS ALTITUDE
                                [meters]
MEAN RADAR ALTITUDE
                                [meters]
MEAN_WIND_DIR
                                [degrees]
MEAN WIND SPEED
                                [meters][second^-1]
                                [degrees Celsius]
MEAN_AIR_TEMP
MEAN POTNTL TEMP
                                [degrees Kelvin]
MEAN H2O MIX RATIO
                                [grams of water vapor][kilogram dry air^-1]
MEAN_U_COMPNT_WIND_VELOC
                                [meters][second^-1]
                                [meters][second^-1]
MEAN_V_COMPNT_WIND_VELOC
MEAN_STATIC_PRESS
                                [kiloPascals]
MEAN SURF RAD TEMP
                                [degrees Celsius]
MEAN_DOWN_TOTAL_RAD
                                [Watts][meter^-2]
MEAN UP TOTAL RAD
                                [Watts][meter^-2]
MEAN_DOWN_LONGWAVE_RAD
                                [Watts][meter^-2]
MEAN UP LONGWAVE RAD
                                [Watts][meter^-2]
MEAN NET RAD
                                [Watts][meter^-2]
MEAN UP PPFD
                                [microEinsteins][meter^-2][second^-1]
                                [microEinsteins][meter^-2][second^-1]
MEAN DOWN PPFD
MEAN AUX RAD
                                [Watts][meter^-2]
                                [unitless]
MEAN GREEN INDEX
                                [micromoles CO2][mole air^-1]
MEAN_CO2_CONC
                                [nanomoles 03][mole air^-1]
MEAN 03 CONC
MEAN CH4 CONC
                                [nanomoles CH4][mole air^-1]
MEAN SAT SIM CH1
                                [unitless]
MEAN_SAT_SIM_CH2
                                [unitless]
MEAN_SAT_SIM_CH3
                                [unitless]
                                [unitless]
MEAN_SAT_SIM_CH4
                                [degrees Celsius]
SDEV AIR TEMP
SDEV POTNTL TEMP
                                [degrees Kelvin]
SDEV H2O MIX RATIO
                                [grams of water vapor][kilogram dry air^-1]
SDEV_U_COMPNT_WIND_VELOC
                                [meters][second^-1]
SDEV_V_COMPNT_WIND_VELOC
                                [meters][second^-1]
SDEV STATIC PRESS
                                [kiloPascals]
SDEV_SURF_RAD_TEMP
                                [degrees Celsius]
SDEV DOWN TOTAL RAD
                                [Watts][meter^-2]
SDEV_UP_TOTAL_RAD
                                [Watts][meter^-2]
SDEV DOWN LONGWAVE RAD
                                [Watts][meter^-2]
                                [Watts][meter^-2]
SDEV_UP_LONGWAVE_RAD
SDEV NET RAD
                                [Watts][meter^-2]
SDEV_UP_PPFD
                                [microEinsteins][meter^-2][second^-1]
```

```
SDEV DOWN PPFD
                                [microEinsteins][meter^-2][second^-1]
SDEV_AUX_RAD
                                [unitless]
                                [unitless]
SDEV GREEN INDEX
SDEV CO2 CONC
                                [micromoles CO2][mole air^-1]
SDEV 03 CONC
                                [nanomoles O3][mole air^-1]
SDEV_CH4_CONC
                                [nanomoles CH4][mole air^-1]
SDEV_SAT_SIM_CH1
                                [unitless]
                                [unitless]
SDEV_SAT_SIM_CH2
SDEV SAT SIM CH3
                                [unitless]
SDEV SAT SIM CH4
                                [unitless]
TREND AIR TEMP
                                [degrees Celsius][meter^-1]
TREND POTNTL TEMP
                                [degrees Kelvin][meter^-1]
TREND_H2O_MIX_RATIO
                                [grams of water vapor][kilogram dry air^-1]
                                [meter^-1]
TREND U COMPNT WIND VELOC
                                [second^-1]
TREND V COMPNT WIND VELOC
                                [second^-1]
TREND_STATIC_PRESS
                                [kiloPascals][meter^-1]
TREND SURF RAD TEMP
                                [degrees Celsius][meter^-1]
TREND_DOWN_TOTAL_RAD
                                [Watts][meter^-3]
                                [Watts][meter^-3]
TREND UP TOTAL RAD
TREND DOWN LONGWAVE RAD
                                [Watts][meter^-3]
TREND UP LONGWAVE RAD
                                [Watts][meter^-3]
TREND GREEN INDEX
                                [meter^-1]
                                [micromoles CO2][mole air^-1][meter^-1]
TREND_CO2_CONC
TREND 03 CONC
                                [nanomoles 03][mole air^-1][meter^-1]
TREND CH4 CONC
                                [nanomoles CH4][mole air^-1][meter^-1]
SDEV VERT GUST RAW
                                [meters][second^-1]
SDEV_U_COMPNT_WIND_VELOC_RAW
                                [meters][second^-1]
SDEV V COMPNT WIND VELOC RAW
                                [meters][second^-1]
SDEV_ALONG_WIND_RAW
                                [meters][second^-1]
                                [meters][second^-1]
SDEV CROSS WIND RAW
SDEV_POTNTL_TEMP_RAW
                                [degrees Kelvin]
                                [grams of water vapor][kilogram dry air^-1]
SDEV H2O MIX RATIO RAW
SDEV_CO2_MIX_RATIO_RAW
                                [unitless]
                                [nanomoles 03][mole air^-1]
SDEV_O3_CONC_RAW
                                [nanomoles CH4][mole air^-1]
SDEV CH4 CONC RAW
SKEW VERT GUST RAW
                                [meters][second^-1]
SKEW U COMPNT WIND VELOC RAW
                                [meters][second^-1]
SKEW_V_COMPNT_WIND_VELOC_RAW
                                [meters][second^-1]
SKEW ALONG WIND RAW
                                [meters][second^-1]
                                [meters][second^-1]
SKEW_CROSS_WIND_RAW
SKEW POTNTL TEMP RAW
                                [degrees Kelvin]
SKEW H2O MIX RATIO RAW
                                [grams of water vapor][kilogram dry air^-1]
SKEW CO2 MIX RATIO
                                [unitless]
                                [nanomoles 03][mole air^-1]
SKEW_O3_CONC_RAW
SKEW_CH4_CONC_RAW
                                [nanomoles CH4][mole air^-1]
                                [meters][second^-1]
KURT VERT GUST RAW
KURT_U_COMPNT_WIND_VELOC_RAW
                                [meters][second^-1]
KURT V COMPNT WIND VELOC RAW
                                [meters][second^-1]
KURT_ALONG_WIND_RAW
                                [meters][second^-1]
KURT CROSS WIND RAW
                                [meters][second^-1]
KURT_POTNTL_TEMP_RAW
                                [degrees Kelvin]
KURT H2O MIX RATIO RAW
                                [grams of water vapor][kilogram dry air^-1]
KURT_CO2_MIX_RATIO_RAW
                                [unitless]
```

```
[nanomoles 03][mole air^-1]
KURT O3 CONC RAW
KURT_CH4_CONC_RAW
                                [nanomoles CH4][mole air^-1]
                                [meters^2][second^-2]
CORC VERT U WIND COMPNT RAW
CORC_VERT_V_WIND_COMPNT_RAW
                                [meters^2][second^-2]
CORC VERT ALONG WIND RAW
                                [meters^2][second^-2]
CORC_VERT_CROSS_WIND_RAW
                                [meters^2][second^-2]
CORC_VERT_POTNTL_TEMP_RAW
                                [degrees Kelvin][meters][second^-1]
                                [grams of water vapor][meters]
CORC_VERT_H2O_MIX_RATIO_RAW
                                [kilogram dry air^-1][second^-1]
CORC_VERT_CO2_MIX_RATIO_RAW
                                [unitless]
CORC_VERT_O3_CONC_RAW
                                [nanomoles 03][meters][mole air^-1][second^-1]
                                [nanomoles CH4][meters][mole air^-1][second^-1]
CORC_VERT_CH4_CONC_RAW
CORC_POTNTL_H2O_MIX_RATIO_RAW
                                [grams of water vapor][degrees Kelvin]
                                [kilogram dry air^-1]
MMNTM_FLUX_V_WIND_COMPNT_RAW
                                [Newtons][meter^-2]
MMNTM FLUX U WIND COMPNT RAW
                                [Newtons][meter^-2]
MMNTM_FLUX_ALONG_MEAN_WIND_RAW [Newtons][meter^-2]
MMNTM_FLUX_CROSS_MEAN_WIND_RAW [Newtons][meter^-2]
                                [Watts][meter^-2]
SENSIBLE_HEAT_FLUX_RAW
LATENT HEAT FLUX RAW
                                [Watts][meter^-2]
                                [micromoles CO2][meter^-2][second^-1]
CO2_FLUX_RAW
O3_FLUX_RAW
                                [nanomoles 03][meter^-2][second^-1]
O3_DEPOSITION_VELOC_RAW
                                [millimeters][second^-1]
CH4_FLUX_RAW
                                [nanomoles CH4][meter^-2][second^-1]
AIR DENSITY CONSTANT
                                [kilograms][meter^-3]
SPECIFIC_HEAT_CONSTANT
                                [Joules][kilogram^-1][degree Kelvin^-1]
LATENT HEAT VAP CONSTANT
                                [Joules][kilogram^-1]
DRY_AIR_GAS_CONSTANT
                                [Joules][kilogram^-1][degree Kelvin^-1]
SDEV_VERT_GUST_DET
                                [meters][second^-1]
SDEV_U_COMPNT_WIND_VELOC_DET
                                [meters][second^-1]
                                [meters][second^-1]
SDEV V COMPNT WIND VELOC DET
SDEV_ALONG_WIND_DET
                                [meters][second^-1]
SDEV_CROSS_WIND_DET
                                [meters][second^-1]
                                [degrees Kelvin]
SDEV_POTNTL_TEMP_DET
SDEV_H2O_MIX_RATIO_DET
                                [grams of water vapor][kilogram dry air^-1]
SDEV CO2 MIX RATIO
                                [unitless]
                                [nanomoles 03][mole air^-1]
SDEV_O3_CONC_DET
SDEV CH4 CONC DET
                                [nanomoles CH4][mole air^-1]
SKEW_VERT_GUST_DET
                                [meters][second^-1]
SKEW_U_COMPNT_WIND_VELOC_DET
                                [meters][second^-1]
                                [meters][second^-1]
SKEW_V_COMPNT_WIND_VELOC_DET
SKEW ALONG WIND DET
                                [meters][second^-1]
                                [meters][second^-1]
SKEW_CROSS_WIND_DET
SKEW_POTNTL_TEMP_DET
                                [degrees Kelvin]
SKEW_H2O_MIX_RATIO_DET
                                [grams of water vapor][kilogram dry air^-1]
SKEW_CO2_MIX_RATIO_DET
                                [unitless]
                                [nanomoles O3][mole air^-1]
SKEW O3 CONC DET
                                [nanomoles CH4][mole air^-1]
SKEW_CH4_CONC_DET
KURT VERT GUST DET
                                [meters][second^-1]
                                [meters][second^-1]
KURT_U_COMPNT_WIND_VELOC_DET
KURT_V_COMPNT_WIND_VELOC_DET
                                [meters][second^-1]
KURT_ALONG_WIND_DET
                                [meters][second^-1]
                                [meters][second^-1]
KURT CROSS WIND DET
KURT_POTNTL_TEMP_DET
                                [degrees Kelvin]
```

```
[grams of water vapor][kilogram dry air^-1]
KURT_H2O_MIX_RATIO_DET
KURT_CO2_MIX_RATIO_DET
                               [unitless]
                               [nanomoles 03][mole air^-1]
KURT O3 CONC DET
KURT_CH4_CONC_DET
                               [nanomoles CH4][mole air^-1]
CORC VERT U WIND COMPNT DET
                               [meters^2][second^-2]
CORC_VERT_V_WIND_COMPNT_DET
                               [meters^2][second^-2]
CORC_VERT_ALONG_WIND_DET
                               [meters^2][second^-2]
CORC_VERT_CROSS_WIND_DET
                               [meters^2][second^-2]
CORC VERT POTNTL TEMP DET
                               [degrees Kelvin][meters][second^-1]
CORC_VERT_H2O_MIX_RATIO_DET
                               [grams of water vapor][meters]
                               [kilogram dry air^-1][second^-1]
CORC_VERT_CO2_MIX_RATIO_DET
                               [unitless]
                               [nanomoles 03][meters][mole air^-1][second^-1]
CORC_VERT_O3_CONC_DET
CORC VERT CH4 CONC DET
                               [nanomoles CH4][meters][mole air^-1][second^-1]
CORC_POTNTL_H2O_MIX_RATIO_DET
                               [grams of water vapor][degrees Kelvin]
                               [kilogram dry air^-1]
MMNTM_FLUX_U_WIND_COMPNT_DET
                               [Newtons][meter^-2]
                               [Newtons][meter^-2]
MMNTM_FLUX_V_WIND_COMPNT_DET
MMNTM_FLUX_ALONG_MEAN_WIND_DET [Newtons][meter^-2]
MMNTM FLUX CROSS MEAN WIND DET [Newtons][meter^-2]
SENSIBLE_HEAT_FLUX_DET
                               [Watts][meter^-2]
LATENT HEAT FLUX DET
                               [Watts][meter^-2]
CO2_FLUX_DET
                               [micromoles CO2][meter^-2][second^-1]
O3_FLUX_DET
                               [nanomoles 03][meter^-2][second^-1]
O3 DEPOSITION VELOC DET
                               [millimeters][second^-1]
CH4_FLUX_DET
                               [nanomoles CH4][meter^-2][second^-1]
CRTFCN CODE
REVISION_DATE
                               [DD-MON-YY]
```

7.3.4 Data Source

Column Name

The sources of the parameter values contained in the data files on the CD-ROM are:

Data Source

COTUME NAME	Data Source
SPATIAL_COVERAGE	[Assigned by BORIS]
RUN_START_DATE	[Supplied by Investigator]
RUN_START_TIME	[Supplied by Investigator]
RUN_END_DATE	[Supplied by Investigator]
RUN_END_TIME	[Supplied by Investigator]
FLUX_MISSION_DESIGNATOR	[Supplied by Investigator]
FLUX_MISSION_NUM	[Supplied by Investigator]
FLUX_PASS_NUM	[Supplied by Investigator]
FLUX_SEGMENT_NUM	[Supplied by Investigator]
START_LATITUDE	[Supplied by Investigator]
START_LONGITUDE	[Supplied by Investigator]
END_LATITUDE	[Supplied by Investigator]
END_LONGITUDE	[Supplied by Investigator]
START_BOREAS_X	[Supplied by Investigator]
START_BOREAS_Y	[Supplied by Investigator]
END_BOREAS_X	[Supplied by Investigator]
END_BOREAS_Y	[Supplied by Investigator]
HEADING	[Supplied by Investigator]
MEAN_PRESS_ALTITUDE	[Supplied by Investigator]
MEAN_RADAR_ALTITUDE	[Supplied by Investigator]

MEAN WIND DIR [Supplied by Investigator] MEAN_WIND_SPEED [Supplied by Investigator] [Supplied by Investigator] MEAN AIR TEMP MEAN POTNTL TEMP [Supplied by Investigator] MEAN H2O MIX RATIO [Supplied by Investigator] MEAN_U_COMPNT_WIND_VELOC [Supplied by Investigator] [Supplied by Investigator] MEAN_V_COMPNT_WIND_VELOC [Supplied by Investigator] MEAN_STATIC_PRESS MEAN SURF RAD TEMP [Supplied by Investigator] MEAN_DOWN_TOTAL_RAD [Supplied by Investigator] MEAN_UP_TOTAL_RAD [Supplied by Investigator] MEAN_DOWN_LONGWAVE_RAD [Supplied by Investigator] [Supplied by Investigator] MEAN_UP_LONGWAVE_RAD [Supplied by Investigator] MEAN NET RAD MEAN UP PPFD [Supplied by Investigator] MEAN DOWN PPFD [Supplied by Investigator] MEAN_AUX_RAD [Supplied by Investigator] MEAN GREEN INDEX [Supplied by Investigator] [Supplied by Investigator] MEAN_CO2_CONC MEAN 03 CONC [Supplied by Investigator] [Supplied by Investigator] MEAN_CH4_CONC MEAN_SAT_SIM_CH1 [Supplied by Investigator] MEAN_SAT_SIM_CH2 [Supplied by Investigator] MEAN_SAT_SIM_CH3 [Supplied by Investigator] [Supplied by Investigator] MEAN SAT SIM CH4 SDEV AIR TEMP [Supplied by Investigator] SDEV POTNTL TEMP [Supplied by Investigator] SDEV_H2O_MIX_RATIO [Supplied by Investigator] SDEV_U_COMPNT_WIND_VELOC [Supplied by Investigator] SDEV_V_COMPNT_WIND_VELOC [Supplied by Investigator] SDEV STATIC PRESS [Supplied by Investigator] SDEV_SURF_RAD_TEMP [Supplied by Investigator] SDEV_DOWN_TOTAL_RAD [Supplied by Investigator] SDEV_UP_TOTAL_RAD [Supplied by Investigator] SDEV_DOWN_LONGWAVE_RAD [Supplied by Investigator] [Supplied by Investigator] SDEV UP LONGWAVE RAD SDEV NET RAD [Supplied by Investigator] SDEV UP PPFD [Supplied by Investigator] SDEV_DOWN_PPFD [Supplied by Investigator] SDEV_AUX_RAD [Supplied by Investigator] SDEV_GREEN_INDEX [Supplied by Investigator] SDEV CO2 CONC [Supplied by Investigator] [Supplied by Investigator] SDEV_O3_CONC SDEV_CH4_CONC [Supplied by Investigator] SDEV_SAT_SIM_CH1 [Supplied by Investigator] SDEV_SAT_SIM_CH2 [Supplied by Investigator] SDEV SAT SIM CH3 [Supplied by Investigator] SDEV_SAT_SIM_CH4 [Supplied by Investigator] TREND AIR TEMP [Supplied by Investigator] TREND_POTNTL_TEMP [Supplied by Investigator] TREND_H2O_MIX_RATIO [Supplied by Investigator] TREND_U_COMPNT_WIND_VELOC [Supplied by Investigator] TREND V COMPNT WIND VELOC [Supplied by Investigator] TREND_STATIC_PRESS [Supplied by Investigator]

TREND_SURF_RAD_TEMP			Investigator]
TREND_DOWN_TOTAL_RAD	[Supplied	by	<pre>Investigator]</pre>
TREND_UP_TOTAL_RAD	[Supplied	by	Investigator]
TREND_DOWN_LONGWAVE_RAD	[Supplied	by	<pre>Investigator]</pre>
TREND_UP_LONGWAVE_RAD	[Supplied	by	Investigator]
TREND_GREEN_INDEX	[Supplied	by	Investigator]
TREND_CO2_CONC	[Supplied	by	<pre>Investigator]</pre>
TREND_O3_CONC	[Supplied	by	Investigator]
TREND_CH4_CONC	[Supplied	by	Investigator]
SDEV_VERT_GUST_RAW	[Supplied	by	<pre>Investigator]</pre>
SDEV_U_COMPNT_WIND_VELOC_RAW	[Supplied	by	<pre>Investigator]</pre>
SDEV_V_COMPNT_WIND_VELOC_RAW	[Supplied	by	<pre>Investigator]</pre>
SDEV_ALONG_WIND_RAW	[Supplied	by	<pre>Investigator]</pre>
SDEV_CROSS_WIND_RAW	[Supplied	by	<pre>Investigator]</pre>
SDEV_POTNTL_TEMP_RAW			Investigator]
SDEV_H2O_MIX_RATIO_RAW			Investigator]
SDEV_CO2_MIX_RATIO_RAW			Investigator]
SDEV_O3_CONC_RAW			Investigator]
SDEV_CH4_CONC_RAW			Investigator]
SKEW_VERT_GUST_RAW			Investigator]
SKEW_U_COMPNT_WIND_VELOC_RAW			Investigator]
SKEW_V_COMPNT_WIND_VELOC_RAW			<pre>Investigator]</pre>
SKEW_ALONG_WIND_RAW			<pre>Investigator]</pre>
SKEW_CROSS_WIND_RAW			<pre>Investigator]</pre>
SKEW_POTNTL_TEMP_RAW			Investigator]
SKEW_H2O_MIX_RATIO_RAW			Investigator]
SKEW_CO2_MIX_RATIO			Investigator]
SKEW_O3_CONC_RAW			Investigator]
SKEW_CH4_CONC_RAW			Investigator]
KURT_VERT_GUST_RAW			Investigator]
KURT_U_COMPNT_WIND_VELOC_RAW			Investigator]
			Investigator]
KURT_V_COMPNT_WIND_VELOC_RAW KURT_ALONG_WIND_RAW			Investigator]
KURT_CROSS_WIND_RAW			Investigator]
KURT_POTNTL_TEMP_RAW			Investigator]
			Investigator]
KURT_H2O_MIX_RATIO_RAW			
KURT_CO2_MIX_RATIO_RAW			Investigator]
KURT_O3_CONC_RAW			Investigator]
KURT_CH4_CONC_RAW			Investigator]
CORC_VERT_U_WIND_COMPNT_RAW		_	Investigator]
CORC_VERT_V_WIND_COMPNT_RAW			Investigator]
CORC_VERT_ALONG_WIND_RAW			Investigator]
CORC_VERT_CROSS_WIND_RAW			<pre>Investigator]</pre>
CORC_VERT_POTNTL_TEMP_RAW			<pre>Investigator]</pre>
CORC_VERT_H2O_MIX_RATIO_RAW		_	<pre>Investigator]</pre>
CORC_VERT_CO2_MIX_RATIO_RAW			Throatiantori
CORC_VERT_O3_CONC_RAW	[Supplied	_	_
	[Supplied	by	Investigator]
CORC_VERT_CH4_CONC_RAW	[Supplied [Supplied	by by	<pre>Investigator] Investigator]</pre>
CORC_VERT_CH4_CONC_RAW CORC_POTNTL_H2O_MIX_RATIO_RAW	[Supplied [Supplied [Supplied	by by	<pre>Investigator] Investigator]</pre>
CORC_VERT_CH4_CONC_RAW CORC_POTNTL_H2O_MIX_RATIO_RAW MMNTM_FLUX_V_WIND_COMPNT_RAW	[Supplied [Supplied [Supplied [Supplied	by by by by	Investigator] Investigator] Investigator] Investigator]
CORC_VERT_CH4_CONC_RAW CORC_POTNTL_H2O_MIX_RATIO_RAW MMNTM_FLUX_V_WIND_COMPNT_RAW MMNTM_FLUX_U_WIND_COMPNT_RAW	[Supplied [Supplied [Supplied [Supplied [Supplied [Supplied]]]]]	by by by by	Investigator] Investigator] Investigator] Investigator] Investigator]
CORC_VERT_CH4_CONC_RAW CORC_POTNTL_H2O_MIX_RATIO_RAW MMNTM_FLUX_V_WIND_COMPNT_RAW MMNTM_FLUX_U_WIND_COMPNT_RAW MMNTM_FLUX_ALONG_MEAN_WIND_RAW	[Supplied [Supplied [Supplied [Supplied [Supplied [Supplied [Supplied]]]]]	by by by by by by	Investigator] Investigator] Investigator] Investigator] Investigator] Investigator]
CORC_VERT_CH4_CONC_RAW CORC_POTNTL_H2O_MIX_RATIO_RAW MMNTM_FLUX_V_WIND_COMPNT_RAW MMNTM_FLUX_U_WIND_COMPNT_RAW	[Supplied [Supplied [Supplied [Supplied [Supplied [Supplied [Supplied [Supplied [Supplied]]]]]	by by by by by by by	Investigator] Investigator] Investigator] Investigator] Investigator]

LATENT_HEAT_FLUX_RAW			Investigator]
CO2_FLUX_RAW			Investigator]
O3_FLUX_RAW			Investigator]
O3_DEPOSITION_VELOC_RAW			Investigator]
CH4_FLUX_RAW			Investigator]
AIR_DENSITY_CONSTANT			Investigator]
SPECIFIC_HEAT_CONSTANT			Investigator]
LATENT_HEAT_VAP_CONSTANT			Investigator]
DRY_AIR_GAS_CONSTANT			Investigator]
SDEV_VERT_GUST_DET			Investigator]
SDEV_U_COMPNT_WIND_VELOC_DET			<pre>Investigator]</pre>
SDEV_V_COMPNT_WIND_VELOC_DET	[Supplied	by	Investigator]
SDEV_ALONG_WIND_DET	[Supplied	by	Investigator]
SDEV_CROSS_WIND_DET	[Supplied	by	<pre>Investigator]</pre>
SDEV_POTNTL_TEMP_DET	[Supplied	by	Investigator]
SDEV_H2O_MIX_RATIO_DET	[Supplied	by	<pre>Investigator]</pre>
SDEV_CO2_MIX_RATIO	[Supplied	by	<pre>Investigator]</pre>
SDEV_O3_CONC_DET	[Supplied	by	<pre>Investigator]</pre>
SDEV_CH4_CONC_DET	[Supplied	by	<pre>Investigator]</pre>
SKEW_VERT_GUST_DET	[Supplied	by	<pre>Investigator]</pre>
SKEW_U_COMPNT_WIND_VELOC_DET	[Supplied	by	<pre>Investigator]</pre>
SKEW_V_COMPNT_WIND_VELOC_DET	[Supplied	by	Investigator]
SKEW_ALONG_WIND_DET			Investigator]
SKEW_CROSS_WIND_DET			Investigator]
SKEW_POTNTL_TEMP_DET			Investigator]
SKEW_H2O_MIX_RATIO_DET			Investigator]
SKEW_CO2_MIX_RATIO_DET			Investigator]
SKEW_O3_CONC_DET			Investigator]
SKEW_CH4_CONC_DET			Investigator]
KURT_VERT_GUST_DET			Investigator]
KURT_U_COMPNT_WIND_VELOC_DET			<pre>Investigator]</pre>
KURT_V_COMPNT_WIND_VELOC_DET			<pre>Investigator]</pre>
KURT_ALONG_WIND_DET			<pre>Investigator]</pre>
KURT_CROSS_WIND_DET			<pre>Investigator]</pre>
KURT_POTNTL_TEMP_DET			<pre>Investigator]</pre>
KURT_H2O_MIX_RATIO_DET			<pre>Investigator]</pre>
KURT_CO2_MIX_RATIO_DET			Investigator]
KURT_03_CONC_DET			Investigator]
KURT_CH4_CONC_DET			Investigator]
CORC_VERT_U_WIND_COMPNT_DET		_	Investigator]
CORC_VERT_V_WIND_COMPNT_DET			Investigator]
CORC_VERT_ALONG_WIND_DET			Investigator]
CORC_VERT_CROSS_WIND_DET			Investigator]
CORC_VERT_POTNTL_TEMP_DET			Investigator]
CORC_VERT_FOINTE_TEMP_DET CORC_VERT_H2O_MIX_RATIO_DET			Investigator]
CORC_VERT_NZO_MIX_RATIO_DET CORC_VERT_CO2_MIX_RATIO_DET		_	Investigator]
CORC_VERT_CO2_MIX_RATIO_DET CORC_VERT_O3_CONC_DET			Investigator]
CORC_VERT_CH4_CONC_DET		_	Investigator]
		_	Investigator]
CORC_POTNTL_H2O_MIX_RATIO_DET			
MMNTM_FLUX_U_WIND_COMPNT_DET			Investigator
MMNTM_FLUX_V_WIND_COMPNT_DET			Investigator
MMNTM_FLUX_ALONG_MEAN_WIND_DET			Investigator
MMNTM_FLUX_CROSS_MEAN_WIND_DET			Investigator]
SENSIBLE_HEAT_FLUX_DET	ranbbried	py	Investigator]

LATENT_HEAT_FLUX_DET	[Supplied	by	Investigator]
CO2_FLUX_DET	[Supplied	by	<pre>Investigator]</pre>
O3_FLUX_DET	[Supplied	by	<pre>Investigator]</pre>
O3_DEPOSITION_VELOC_DET	[Supplied	by	<pre>Investigator]</pre>
CH4_FLUX_DET	[Supplied	by	<pre>Investigator]</pre>
CRTFCN_CODE	[Assigned	by	BORIS]
REVISION_DATE	[Assigned	by	BORIS]

7.3.5 Data RangeThe following table gives information about the parameter values contained in the data files on the CD-ROM:

	Minimum Data	Maximum Data	Missng Data	Unrel Data	Below Detect	Data Not
Column Name	Value	Value	Value	Value	Limit	Cllctd
SPATIAL_COVERAGE	N/A	N/A	None	None	None	None
RUN_START_DATE	25-MAY-94	15-SEP-94	None	None	None	None
RUN_START_TIME	1329	235845	None	None	None	None
RUN_END_DATE	25-MAY-94	15-SEP-94	None	None	None	None
RUN_END_TIME	1429	235945	None	None	None	None
FLUX_MISSION_	CS	XX	None	None	None	None
DESIGNATOR						
FLUX_MISSION_NUM	1	4	None	None	None	None
FLUX_PASS_NUM	1	45	None	None	None	None
FLUX_SEGMENT_NUM	1	106	None	None	None	None
START_LATITUDE	53.53872	54.14089	None	None	None	None
START_LONGITUDE	-106.56947	-102.91473	None	None	None	None
END_LATITUDE	53.53492	54.14185	None	None	None	None
END_LONGITUDE	-106.57997	-102.91473	None	None	None	None
START_BOREAS_X	292.631	531.101	None	None	None	None
START_BOREAS_Y	293.088	365.07	None	None	None	None
END_BOREAS_X	291.976	531.242	None	None	None	None
END_BOREAS_Y	292.951	365.389	None	None	None	None
HEADING	. 2	359.6	None	None	None	None
MEAN_PRESS_ALTITUDE	-593.9	873.1	-999	None	None	None
MEAN_RADAR_ALTITUDE	12.2	762	-999	None	None	None
MEAN_WIND_DIR	0	359.9	None	None	None	None
MEAN_WIND_SPEED	.02	22.35	None	None	None	None
MEAN_AIR_TEMP	7.85	26.98	None	None	None	None
MEAN_POTNTL_TEMP	285.2	305.22	None	None	None	None
MEAN_H2O_MIX_RATIO	.08	13.15	None	None	None	None
MEAN_U_COMPNT_WIND_	-16.35	15.14	None	None	None	None
VELOC						
MEAN_V_COMPNT_WIND_	-9.37	16.44	None	None	None	None
VELOC						
MEAN_STATIC_PRESS	91.52	96.65	None	None	None	None
MEAN_SURF_RAD_TEMP	4.1	41	None	None	None	None
MEAN_DOWN_TOTAL_RAD			-999	None	None	None
MEAN_UP_TOTAL_RAD			-999	None	None	None
MEAN_DOWN_LONGWAVE_			-999	None	None	None
RAD						
MEAN_UP_LONGWAVE_RAD			-999	None	None	None
MEAN_NET_RAD	-54.6	807.1	-999	None	None	None

MEAN_UP_PPFD	10.6	405.5	None	None	None	None
MEAN_DOWN_PPFD	-8.8	2234.3	None	None	None	None
MEAN_AUX_RAD			-999	None	None	None
MEAN_GREEN_INDEX			-999	None	None	None
MEAN_CO2_CONC	516.5	677.9	None	None	None	None
MEAN_O3_CONC			-999	None	None	None
MEAN_CH4_CONC			-999	None	None	None
MEAN_SAT_SIM_CH1			-999	None	None	None
MEAN_SAT_SIM_CH2			-999	None	None	None
MEAN_SAT_SIM_CH3			-999	None	None	None
MEAN_SAT_SIM_CH4			-999	None	None	None
SDEV_AIR_TEMP	.1	1.66	None	None	None	None
SDEV_POTNTL_TEMP	.1	1.81	None	None	None	None
SDEV_H2O_MIX_RATIO	.1	8.58	None	None	None	None
SDEV_U_COMPNT_WIND_	. 2	23.81	None	None	None	None
VELOC						
SDEV_V_COMPNT_WIND_	.1	26.52	None	None	None	None
VELOC						
SDEV_STATIC_PRESS	.1	17.5	None	None	None	None
SDEV SURF RAD TEMP	.1	11.62	None	None	None	None
SDEV_DOWN_TOTAL_RAD			-999	None	None	None
SDEV_UP_TOTAL_RAD			-999	None	None	None
SDEV_DOWN_LONGWAVE_			-999	None	None	None
RAD						
SDEV_UP_LONGWAVE_RAD			-999	None	None	None
SDEV_NET_RAD	.1	227.2	None	None	None	None
SDEV_UP_PPFD	. 4	136.6	None	None	None	None
SDEV_DOWN_PPFD	.3	871.1	None	None	None	None
SDEV_BOWN_IIIB	. 5	071.1	-999	None	None	None
SDEV_RON_RUNDEX			-999	None	None	None
SDEV_CO2_CONC	.1	62.2	None	None	None	None
SDEV_COZ_CONC SDEV_O3_CONC	.1	.1	None	None	None	None
SDEV_CH4_CONC	• -	• +	-999	None	None	None
SDEV_CH4_CONC SDEV_SAT_SIM_CH1			-999 -999	None	None	None
			-999 -999	None	None	None
SDEV_SAT_SIM_CH2 SDEV SAT SIM CH3			-999 -999	None	None	None
SDEV_SAT_SIM_CH4			-999 000	None	None	None
TREND_AIR_TEMP			-999 -999	None	None	None
TREND_POTNTL_TEMP				None	None	None
TREND_H2O_MIX_RATIO			-999	None	None	None
TREND_U_COMPNT_WIND_			-999	None	None	None
VELOC			0.00			
TREND_V_COMPNT_WIND_			-999	None	None	None
VELOC						
TREND_STATIC_PRESS			-999	None	None	None
TREND_SURF_RAD_TEMP			-999	None	None	None
TREND_DOWN_TOTAL_RAD			-999	None	None	None
TREND_UP_TOTAL_RAD			-999	None	None	None
TREND_DOWN_LONGWAVE_			-999	None	None	None
RAD						
TREND_UP_LONGWAVE_			-999	None	None	None
RAD						
TREND_GREEN_INDEX			-999	None	None	None
TREND_CO2_CONC			-999	None	None	None

TREND_O3_CONC			-999	None	None	None
TREND_CH4_CONC			-999	None	None	None
SDEV_VERT_GUST_RAW	.1	5.05	None	None	None	None
SDEV_U_COMPNT_WIND_	. 2	9.33	-999	None	None	None
VELOC_RAW						
SDEV_V_COMPNT_WIND_	.1	9.01	-999	None	None	None
VELOC_RAW						
SDEV_ALONG_WIND_RAW			-999	None	None	None
SDEV_CROSS_WIND_RAW			-999	None	None	None
SDEV_POTNTL_TEMP_RAW	.1	1.81	None	None	None	None
SDEV_H2O_MIX_RATIO_	.1	8.58	None	None	None	None
RAW						
SDEV_CO2_MIX_RATIO_	.1	62.2	None	None	None	None
RAW						
SDEV_O3_CONC_RAW			-999	None	None	None
SDEV_CH4_CONC_RAW			-999	None	None	None
SKEW VERT GUST RAW	-4.16	3.86	None	None	None	None
SKEW_U_COMPNT_WIND_	-2.65	3.02	None	None	None	None
VELOC RAW						
SKEW V COMPNT WIND	-2.55	3.38	None	None	None	None
VELOC RAW						
SKEW ALONG WIND RAW			-999	None	None	None
SKEW CROSS WIND RAW			-999	None	None	None
SKEW_POTNTL_TEMP_RAW	-4 53	4.4	None	None	None	None
SKEW_H2O_MIX_RATIO_	-3.31	3.75	None	None	None	None
RAW	3.31	3.73	IVOITE	NOTIC	NOTIC	110110
SKEW_CO2_MIX_RATIO	-5.09	6.45	None	None	None	None
SKEW_O3_CONC_RAW	3.05	0.15	-999	None	None	None
SKEW_OS_CONC_RAW			-999	None	None	None
KURT_VERT_GUST_RAW	.23	22.7	None	None	None	None
KURT_U_COMPNT_WIND_	1.43	14.08	None	None	None	None
VELOC RAW	1.43	14.00	NOTIE	NOTIC	NOTIE	NOHE
KURT_V_COMPNT_WIND_	1.33	15.53	None	None	None	None
VELOC RAW	1.33	13.33	NOTIE	None	NOTIE	MOHE
KURT ALONG WIND RAW			-999	None	None	None
			-999 -999	None	None	None
KURT_CROSS_WIND_RAW KURT_POTNTL_TEMP_RAW	0	28.66				
			None None	None	None	None
KURT_H2O_MIX_RATIO_ RAW	0	23.83	None	None	None	None
	.35	47.46	None	Mono	None	Mono
KURT_CO2_MIX_RATIO_	. 35	47.40	None	None	None	None
RAW			0.00	NT	NT	N T
KURT_O3_CONC_RAW			-999	None	None	None
KURT_CH4_CONC_RAW			-999	None	None	None
CORC_VERT_U_WIND_			-999	None	None	None
COMPNT_RAW			0.00			
CORC_VERT_V_WIND_			-999	None	None	None
COMPNT_RAW			222			
CORC_VERT_ALONG_WIND	_		-999	None	None	None
RAW						
CORC_VERT_CROSS_WIND	_		-999	None	None	None
RAW			000			
CORC_VERT_POTNTL_			-999	None	None	None
TEMP_RAW						
CORC_VERT_H2O_MIX_			-999	None	None	None

RATIO_RAW			000	None	None	None
CORC_VERT_CO2_MIX_			-999	None	None	None
RATIO_RAW			-999	None	None	Mono
CORC_VERT_O3_CONC_ RAW			-999	None	None	None
CORC_VERT_CH4_CONC_			-999	None	None	None
RAW			- 333	MOHE	NOME	NOHE
CORC_POTNTL_H2O_MIX_			-999	None	None	None
RATIO_RAW)))	NOHE	NOME	None
MMNTM_FLUX_V_WIND_	-8.2294	6.1139	-999	None	None	None
COMPNT_RAW	0.2271	0.1137		WOIIC	WOIIC	NOTIC
MMNTM FLUX U WIND	-8.3104	13.7382	-999	None	None	None
COMPNT_RAW						
MMNTM_FLUX_ALONG_			-999	None	None	None
MEAN_WIND_RAW						
MMNTM_FLUX_CROSS_			-999	None	None	None
MEAN_WIND_RAW						
SENSIBLE_HEAT_FLUX_	-460.2	699.6	-999	None	None	None
RAW						
LATENT_HEAT_FLUX_RAW	-581.2	1856.6	-999	None	None	None
CO2_FLUX_RAW	-9.327	17.449	None	None	None	None
O3_FLUX_RAW			-999	None	None	None
O3_DEPOSITION_VELOC_			-999	None	None	None
RAW						
CH4_FLUX_RAW			-999	None	None	None
AIR_DENSITY_CONSTANT	1.079	1.172	None	None	None	None
SPECIFIC_HEAT_	1004	1004	None	None	None	None
CONSTANT						
LATENT_HEAT_VAP_	2434	2481	None	None	None	None
CONSTANT						
DRY_AIR_GAS_CONSTANT	287.04	287.04	None	None	None	None
SDEV_VERT_GUST_DET			-999	None	None	None
SDEV_U_COMPNT_WIND_			-999	None	None	None
VELOC_DET			000			
SDEV_V_COMPNT_WIND_			-999	None	None	None
VELOC_DET			000	NT	NT	NT
SDEV_ALONG_WIND_DET			-999	None	None	None
SDEV_CROSS_WIND_DET SDEV_POTNTL_TEMP_DET			-999 -999	None	None	None
			-999 -999	None None	None	None
SDEV_H2O_MIX_RATIO_ DET			- 333	MOHE	None	None
SDEV CO2 MIX RATIO			-999	None	None	None
SDEV_CO2_MIX_RATIO			-999	None	None	None
SDEV_CH4_CONC_DET			-999	None	None	None
SKEW_VERT_GUST_DET			-999	None	None	None
SKEW_U_COMPNT_WIND_			-999	None	None	None
VELOC_DET			,,,,	1,0110	1,0110	1,0110
SKEW_V_COMPNT_WIND_			-999	None	None	None
VELOC_DET						
SKEW ALONG WIND DET			-999	None	None	None
SKEW_CROSS_WIND_DET			-999	None	None	None
SKEW_POTNTL_TEMP_DET			-999	None	None	None
SKEW_H2O_MIX_RATIO_			-999	None	None	None
DET				•		_

SKEW_CO2_MIX_RATIO_	-999	None	None	None
DET				
SKEW_O3_CONC_DET	-999	None	None	None
SKEW_CH4_CONC_DET	-999	None	None	None
KURT_VERT_GUST_DET	-999	None	None	None
KURT_U_COMPNT_WIND_	-999	None	None	None
VELOC_DET				
KURT_V_COMPNT_WIND_	-999	None	None	None
VELOC_DET				
KURT_ALONG_WIND_DET	-999	None	None	None
KURT_CROSS_WIND_DET	-999	None	None	None
KURT_POTNTL_TEMP_DET	-999	None	None	None
KURT_H2O_MIX_RATIO_	-999	None	None	None
DET				
KURT_CO2_MIX_RATIO_	-999	None	None	None
DET				
KURT O3 CONC DET	-999	None	None	None
KURT_CH4_CONC_DET	-999	None	None	None
CORC_VERT_U_WIND_	-999	None	None	None
COMPNT DET		WOIIC	IVOITE	WOIIC
CORC_VERT_V_WIND_	-999	None	None	None
COMPNT DET	222	NOTIC	NOTIC	NOTIC
CORC VERT ALONG WIND	-999	None	None	None
DET	- 333	MOHE	None	NOHE
	000	None	None	None
CORC_VERT_CROSS_WIND_	-999	None	None	None
DET	0.00	Mara	Mono	Mana
CORC_VERT_POTNTL_	-999	None	None	None
TEMP_DET	0.00			
CORC_VERT_H2O_MIX_	-999	None	None	None
RATIO_DET				
CORC_VERT_CO2_MIX_	-999	None	None	None
RATIO_DET				
CORC_VERT_O3_CONC_	-999	None	None	None
DET				
CORC_VERT_CH4_CONC_	-999	None	None	None
DET				
CORC_POTNTL_H2O_MIX_	-999	None	None	None
RATIO_DET				
MMNTM_FLUX_U_WIND_	-999	None	None	None
COMPNT_DET				
MMNTM_FLUX_V_WIND_	-999	None	None	None
COMPNT_DET				
MMNTM_FLUX_ALONG_	-999	None	None	None
MEAN_WIND_DET				
MMNTM_FLUX_CROSS_	-999	None	None	None
MEAN_WIND_DET				
SENSIBLE HEAT FLUX	-999	None	None	None
DET				
LATENT_HEAT_FLUX_DET	-999	None	None	None
CO2_FLUX_DET	-999	None	None	None
O3_FLUX_DET	-999	None	None	None
O3_DEPOSITION_VELOC_	-999	None	None	None
DET				
CH4 FLUX DET	-999	None	None	None
0111_11011_DB1	222	140110	140110	140110

CRTFCN_CODE		CPI	CPI	None	None	None	None
REVISION_DATE		26-APR-99	27-APR-99	None	None	None	None
Minimum Data Value Maximum Data Value Missng Data Value		The maximum va The value that indicate that	alue found in	the colum ssing dat s made to	n. a. This determ	ine the	to
Unrel Data Value		parameter valu	t indicates un n attempt was ue, but the va the analysis	made to d lue was d	etermin eemed t	e the	used
Below Detect Limit		instruments de indicate that parameter valuthat the param	t indicates pa etection limit an attempt wa ue, but the an meter value wa instrumentatio	s. This s made to alysis pe s below t	is used determ rsonnel	to ine the determi	
Data Not Cllctd		indicates that not identical	parameter val t BORIS combin data sets int icular science	ue. This ed severa o the sam	usuall l simil e data	Y ar but	le
	th	at blank spaces at the value is at no values of	s not applicab	le to the	respec	tive col	

7.4 Sample Data Record

The following are wrapped versions of data record from a sample moving window data file on the CD-ROM:

SPATIAL_COVERAGE, RUN_START_DATE, RUN_START_TIME, RUN_END_DATE, RUN_END_TIME, FLUX_MISSION_DESIGNATOR, FLUX_MISSION_NUM, FLUX_PASS_NUM, FLUX_SEGMENT_NUM, START_LATITUDE, START_LONGITUDE, END_LATITUDE, END_LONGITUDE, START_BOREAS_X, START_BOREAS_Y, END_BOREAS_X, END_BOREAS_Y, HEADING, MEAN_PRESS_ALTITUDE, MEAN_RADAR_ALTITUDE, MEAN_WIND_DIR, MEAN_WIND_SPEED, MEAN_AIR_TEMP, MEAN_POTNTL_TEMP, MEAN_H2O_MIX_RATIO, MEAN_U_COMPNT_WIND_VELOC, MEAN_V_COMPNT_WIND_VELOC, MEAN_STATIC_PRESS, MEAN_SURF_RAD_TEMP, MEAN_DOWN_TOTAL_RAD, MEAN_UP_TOTAL_RAD, MEAN_DOWN_LONGWAVE_RAD, MEAN_UP_LONGWAVE_RAD, MEAN_NET_RAD, MEAN_UP_PPFD, MEAN_DOWN_PPFD, MEAN_AUX_RAD, MEAN_GREEN_INDEX, MEAN_CO2_CONC, MEAN_O3_CONC, MEAN_CH4_CONC, MEAN_SAT_SIM_CH1, MEAN_SAT_SIM_CH2, MEAN_SAT_SIM_CH3, MEAN_SAT_SIM_CH4, SDEV_AIR_TEMP, SDEV_POTNTL_TEMP, SDEV_H2O_MIX_RATIO, SDEV_U_COMPNT_WIND_VELOC, SDEV_V_COMPNT_WIND_VELOC, SDEV_STATIC_PRESS, SDEV_SURF_RAD_TEMP, SDEV_DOWN_TOTAL_RAD, SDEV_UP_TOTAL_RAD, SDEV_DOWN_LONGWAVE_RAD, SDEV_UP_LONGWAVE_RAD, SDEV_NET_RAD, SDEV_UP_PPFD, SDEV_DOWN_PPFD, SDEV_AUX_RAD, SDEV_GREEN_INDEX,SDEV_CO2_CONC,SDEV_O3_CONC,SDEV_CH4_CONC,SDEV_SAT_SIM_CH1, SDEV_SAT_SIM_CH2, SDEV_SAT_SIM_CH3, SDEV_SAT_SIM_CH4, TREND_AIR_TEMP, TREND_POTNTL_TEMP, TREND_H2O_MIX_RATIO, TREND_U_COMPNT_WIND_VELOC, TREND_V_COMPNT_WIND_VELOC, TREND_STATIC_PRESS, TREND_SURF_RAD_TEMP, TREND_DOWN_TOTAL_RAD, TREND_UP_TOTAL_RAD, TREND_DOWN_LONGWAVE_RAD,

```
TREND UP LONGWAVE RAD, TREND GREEN INDEX, TREND CO2 CONC, TREND O3 CONC,
TREND_CH4_CONC, SDEV_VERT_GUST_RAW, SDEV_U_COMPNT_WIND_VELOC_RAW,
SDEV V COMPNT WIND VELOC RAW, SDEV ALONG WIND RAW, SDEV CROSS WIND RAW,
SDEV POTNTL TEMP RAW, SDEV H2O MIX RATIO RAW, SDEV CO2 MIX RATIO RAW,
SDEV 03 CONC RAW, SDEV CH4 CONC RAW, SKEW VERT GUST RAW,
SKEW_U_COMPNT_WIND_VELOC_RAW, SKEW_V_COMPNT_WIND_VELOC_RAW, SKEW_ALONG_WIND_RAW,
SKEW_CROSS_WIND_RAW, SKEW_POTNTL_TEMP_RAW, SKEW_H2O_MIX_RATIO_RAW,
SKEW_CO2_MIX_RATIO,SKEW_O3_CONC_RAW,SKEW_CH4_CONC_RAW,KURT_VERT_GUST_RAW,
KURT U COMPNT WIND VELOC RAW, KURT V COMPNT WIND VELOC RAW, KURT ALONG WIND RAW,
KURT_CROSS_WIND_RAW, KURT_POTNTL_TEMP_RAW, KURT_H2O_MIX_RATIO_RAW,
KURT_CO2_MIX_RATIO_RAW, KURT_O3_CONC_RAW, KURT_CH4_CONC_RAW,
CORC_VERT_U_WIND_COMPNT_RAW, CORC_VERT_V_WIND_COMPNT_RAW,
CORC_VERT_ALONG_WIND_RAW, CORC_VERT_CROSS_WIND_RAW, CORC_VERT_POTNTL_TEMP_RAW,
CORC VERT H20 MIX RATIO RAW, CORC VERT CO2 MIX RATIO RAW, CORC VERT O3 CONC RAW,
CORC VERT CH4 CONC RAW, CORC POTNTL H20 MIX RATIO RAW,
MMNTM FLUX V WIND COMPNT RAW, MMNTM FLUX U WIND COMPNT RAW,
MMNTM_FLUX_ALONG_MEAN_WIND_RAW, MMNTM_FLUX_CROSS_MEAN_WIND_RAW,
SENSIBLE HEAT FLUX RAW, LATENT HEAT FLUX RAW, CO2 FLUX RAW, O3 FLUX RAW,
O3_DEPOSITION_VELOC_RAW, CH4_FLUX_RAW, AIR_DENSITY_CONSTANT,
SPECIFIC HEAT CONSTANT, LATENT HEAT VAP CONSTANT, DRY AIR GAS CONSTANT,
SDEV VERT GUST DET, SDEV U COMPNT WIND VELOC DET, SDEV V COMPNT WIND VELOC DET,
SDEV ALONG WIND DET, SDEV CROSS WIND DET, SDEV POTNTL TEMP DET,
SDEV_H2O_MIX_RATIO_DET,SDEV_CO2_MIX_RATIO,SDEV_O3_CONC_DET,SDEV_CH4_CONC_DET,
SKEW_VERT_GUST_DET,SKEW_U_COMPNT_WIND_VELOC_DET,SKEW_V_COMPNT_WIND_VELOC_DET,
SKEW ALONG WIND DET, SKEW CROSS WIND DET, SKEW POTNTL TEMP DET,
SKEW H2O MIX RATIO DET, SKEW CO2 MIX RATIO DET, SKEW O3 CONC DET,
SKEW CH4 CONC DET, KURT VERT GUST DET, KURT U COMPNT WIND VELOC DET,
KURT_V_COMPNT_WIND_VELOC_DET, KURT_ALONG_WIND_DET, KURT_CROSS_WIND_DET,
KURT_POTNTL_TEMP_DET, KURT_H2O_MIX_RATIO_DET, KURT_CO2_MIX_RATIO_DET,
KURT O3 CONC DET, KURT CH4 CONC DET, CORC VERT U WIND COMPNT DET,
CORC VERT V WIND COMPNT DET, CORC VERT ALONG WIND DET, CORC VERT CROSS WIND DET,
CORC_VERT_POTNTL_TEMP_DET, CORC_VERT_H2O_MIX_RATIO_DET,
CORC_VERT_CO2_MIX_RATIO_DET,CORC_VERT_O3_CONC_DET,CORC_VERT_CH4_CONC_DET,
CORC_POTNTL_H2O_MIX_RATIO_DET,MMNTM_FLUX_U_WIND_COMPNT_DET,
MMNTM_FLUX_V_WIND_COMPNT_DET,MMNTM_FLUX_ALONG_MEAN_WIND_DET,
MMNTM FLUX CROSS MEAN WIND DET, SENSIBLE HEAT FLUX DET, LATENT HEAT FLUX DET,
CO2_FLUX_DET,O3_FLUX_DET,O3_DEPOSITION_VELOC_DET,CH4_FLUX_DET,CRTFCN_CODE,
REVISION DATE
'SSA',28-JUL-94,153247,28-JUL-94,153347,'CS',1,1,28,53.752,-105.71899,53.75794,
-105.6973,347.727,319.367,349.102,320.135,63.1,579.1,21.2,323.3,2.42,23.83,301.4,
10.41,1.45,-1.94,94.97,25.8,-999.0,-999.0,-999.0,-999.0,347.3,301.2,1009.0,
-999.0,-999.0,567.4,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,.16,.15,.26,.95,
.83,.4,.95,-999.0,-999.0,-999.0,-999.0,4.3,2.0,24.7,-999.0,-999.0,.9,.1,-999.0,
-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,
-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,.57,.95,.83,-999.0,
-999.0,.15,.26,.9,-999.0,-999.0,-.22,-.33,-.01,-999.0,-999.0,.09,-.29,.51,
-999.0, -999.0, 2.88, 2.18, 2.54, -999.0, -999.0, 2.94, 2.4, 2.25, -999.0, -999.0, -999.0,
-999.0, -999.0, -999.0, -999.0, -999.0, -999.0, -999.0, -999.0, -999.0, -1835, .347,
-999.0, -999.0, 112.6, 273.5, -.231, -999.0, -999.0, -999.0, 1.096, 1004.0, 2442, 287.04,
-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,
-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,
-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,
-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,
-999.0,-999.0,-999.0,-999.0,-999.0,-999.0,'CPI',26-APR-99
```

8. Data Organization

8.1 Data Granularity

The smallest orderable data set available is one file of flux runs during a day. Note that although there are less than 100 records in any data file, there are over 170 columns of data. Most spreadsheet software should be able to handle up to 256 columns of data.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain ASCII numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

See Section 17.1.

9.1.1 Derivation Techniques and Algorithms

See Section 17.1.

9.2 Data Processing Sequence

Not available at this revision.

9.2.1 Processing Steps

See Section 17.1.

9.2.2 Processing Changes

None.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

None.

9.3.2 Calculated Variables

None.

9.4 Graphs and Plots

None.

10. Errors

10.1 Sources of Error

None given.

10.2 Quality Assessment

10.2.1 Data Validation by Source

Care has been taken in the collection and analysis of the Long-EZ data. The wind measuring system is continually monitored for accuracy using techniques such as wind boxes, control input cases, and intercomparisons with other aircraft. Cospectral plots have been used to check the flux contributions at all wavelengths to ensure that they were not contaminated by inadequate compensation for aircraft motion.

10.2.2 Confidence Level/Accuracy Judgment

See Section 10.2.1.

10.2.3 Measurement Error for Parameters

Not available.

10.2.4 Additional Quality Assessments

Aircraft intercomparison was made by the investigators.

10.2.5 Data Verification by Data Center

BORIS staff loaded the data into the data base and checked the values to make sure that they were within a reasonable range.

11. Notes

11.1 Limitations of the Data

None given.

11.2 Known Problems with the Data

See Section 6.2.

11.3 Usage Guidance

None given.

11.4 Other Relevant Information

None.

12. Application of the Data Set

These data can be used to create algorithms to relate boundary-layer processes to satellite-derived data.

13. Future Modifications and Plans

None.

14. Software

14.1 Software Description

None.

14.2 Software Access

Not applicable.

15. Data Access

The NOAA/ATDD Long-EZ aircraft flux data over the SSA are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services Oak Ridge National Laboratory P.O. Box 2008 MS-6407 Oak Ridge, TN 37831-6407

Phone: (423) 241-3952 Fax: (423) 574-4665

E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products

None.

16.3 Other Products

These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation

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17.2 Journal Articles and Study Reports

Newcomer, J., D. Landis, S. Conrad, S. Curd, K. Huemmrich, D. Knapp, A. Morrell, J. Nickeson, A. Papagno, D. Rinker, R. Strub, T. Twine, F. Hall, and P. Sellers, eds. 2000. Collected Data of The Boreal Ecosystem-Atmosphere Study. NASA. CD-ROM.

Sellers, P. and F. Hall. 1994. Boreal Ecosystem-Atmosphere Study: Experiment Plan. Version 1994-3.0, NASA BOREAS Report (EXPLAN 94).

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17.3 Archive/DBMS Usage Documentation None.

18. Glossary of Terms

None.

19. List of Acronyms

AFM - Airborne Flux and Meteorology

ASCII - American Standard Code for Information Interchange

ATDD - Atmospheric Turbulence and Diffusion Division

BOREAS - BOReal Ecosystem-Atmosphere Study

BORIS - BOREAS Information System CD-ROM - Compact Disk-Read-Only Memory

CG - Center of Gravity

DAAC - Distributed Active Archive Center

DGPS - Differential Global Positioning System

EOS - Earth Observing System

EOSDIS - EOS Data and Information System
GIS - Geographic Information System

GMT - Greenwich Mean Time

GPS - Global Positioning System
GSFC - Goddard Space Flight Center
HTML - HyperText Markup Language
IFC - Intensive Field Campaign
IRGA - Infrared Gas Analyzer

NAD83 - North American Datum of 1983

NASA - National Aeronautics and Space Administration NOAA - National Oceanic and Atmospheric Administration

NSA - Northern Study Area

OA - Old Aspen

OBS - Old Black Spruce OJP - Old Jack Pine

ORNL - Oak Ridge National Laboratory PANP - Prince Albert National Park

PAR - Photosynthetically Active Radiation

POD - Processed Output Data
QA - Quality Assurance
SSA - Southern Study Area
URL - Uniform Resource Locator

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13. ABSTRACT (Maximum 200 words)

This data set contains measurements from the AFM-1 NOAA/ATDD Long-EZ Aircraft collected during the 1994 IFCs at the SSA. These measurements were made from various instruments mounted on the aircraft. The data that were collected include aircraft altitude, wind direction, wind speed, air temperature, potential temperature, water mixing ratio, U and V components of wind velocity, static pressure, surface radiative temperature, downwelling and upwelling total radiation, downwelling and upwelling longwave radiation, net radiation, downwelling and upwelling PAR, greenness index, CO₂ concentration, O₃ concentration, and CH₄ concentration. There are also various columns that indicate the standard deviation, skewness, kurtosis, and trend of some of these data. The data are stored in tabular ASCII files.

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